Proceedings of the

American Association of Textile Chemists and Colorists

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FEBRUARY 2, 1953

CALENDAR

AATCC

COUNCIL
April 17, June 5.

GENERAL RESEARCH COMMITTEE
(See Council dates)

NATIONAL CONVENTIONS
September 17-19, 1953 (Hotel Conrad Hilton, Chicago); 1954 (Atlanta, Ga); Sept 21-23, 1955 (Chalfonte-Haddon Hall, Atlantic City, N J).

HUDSON-MOHAWK SECTION
February 6, March 20, May 8 (Albany); June 19 (Outing).

MID-WEST SECTION
February 14 (Hotel Bismarck, Chicago, Ill); April 18 (Netherland Plaza, Cincinnati, O); June 20 (Outing, Lake Delavan, Wis); November 7 (Hotel Bismarck).

NEW YORK SECTION
February 27 (Hotel Statler, New York, N Y); April 17, May 22 (Swiss Chalet).

NORTHERN NEW ENGLAND SECTION
Mar 6 (MIT Faculty House, Cambridge); April 17 (Lowell Textile Inst, Lowell); May 15 (Andover CC, Andover); June 12 (Annual Outing); Nov 6 (LTI); Dec. 4 (MIT Faculty House).

PHILADELPHIA SECTION
Mar 6 (Kugler's Restaurant, Phila); April 24; May 22 (Outing, Manufacturer's Golf & Country Club); Sept 11; Oct 23; Dec 4; Jan 15, 1954.

PACIFIC SOUTHWEST SECTION
April 24 (Nikabob Cafe, Los Angeles).

PIEDMONT SECTION
April 11, (Robert E Lee Hotel, Winston-Salem, N C); June 12-13 (Mayview Manor, Blowing Rock, N C); Sept 12 (Hotel Charlotte, Charlotte, N C).

RHODE ISLAND SECTION
Feb 22 (Johnson's Grill, Providence); Mar 27 (Providence Eng Soc); Apr 24 (Wannamoisett C C); May 22 (Prov Eng Soc); June 12 (Outing, Wannamoisett C C); Oct 23 (Prov Eng Soc); Dec 4 (Annual Meeting, Sheraton - Biltmore, Providence).

SOUTH CENTRAL SECTION
Feb 28, May 23 (Patten Hotel, Chattanooga, Tenn); Aug 21-22 (Outing, Chattanooga Golf & Country Club, Chattanooga, Tenn); Dec 5 (Patten Hotel).

WESTERN NEW ENGLAND SECTION
Mar 20 (Rapp's Restaurant, Shelton, Conn); May 8 (Ladies Night); June 19 (Outing); Oct 2, Nov 6 and Dec 11 (Rapp's).

OTHER EVENTS

AMERICAN OIL CHEMISTS' SOCIETY
44th Annual Meeting, May 4-6, Roosevelt Hotel, New Orleans, La; 27th Fall Meeting, November 2-4, Sherman Hotel, Chicago, Ill.

AMERICAN SOCIETY FOR QUALITY CONTROL
Textile Division: May 27-29, Convention Hall, Philadelphia, Pa.

AMERICAN SOCIETY FOR TESTING MATERIALS
1953 Annual Meeting, June 29-July 3, Chalfonte-Haddon Hall, Atlantic City, N J.

AMERICAN TEXTILE MACHINERY ASSOCIATION
Exhibit of American Textile Machinery, April 26-May 1, 1954, Atlantic City Exhibition Hall, Atlantic City, N J.

ASSOCIATION OF CONSULTING CHEMISTS AND CHEMICAL ENGINEERS, INC
April 21 (Hotel Belmont Plaza, New York, N Y—Symposium and Dinner); Annual Meeting —25th Anniversary-October 27 (Hotel Belmont Plaza, New York).

CANADIAN ASSOCIATION OF TEXTILE COLOURISTS AND CHEMISTS (Quebec Section)
Feb 21, Mar 21 (Physical Science Centre, McGill Univ, Montreal, Que); April 17-18 (Annual Meeting, Mount Royal Hotel, Montreal, Que); June 20 (Annual Golf Tournament).

GARMENT DYERS GUILD OF AMERICA
1953 Technical Clinic, November, Steuewe Plant, Rochester, N Y.

NATIONAL ASSOCIATION OF HOSIERY MANUFACTURERS
41st Knitting Arts Exhibition, April 27-May 1, Atlantic City Auditorium, Atlantic City, N J.

NATIONAL COTTON COUNCIL
4th Annual Cotton Research Clinic, Feb 18-20, Oglethorpe Hotel, Savannah, Ga.

NATIONAL INSTITUTE OF CLEANING AND DYEING
44th Annual Convention, Feb 13-15, Statler Hotel, Cleveland, O.

NEW YORK BOARD OF TRADE (DCAT)
27th Annual Drug, Chemical and Allied Trades Dinner, March 5, Waldorf-Astoria, New York, N Y.
Drug, Chemical and Allied Trades Section; 63rd Annual Meeting, Sept 24-27, Pocono Manor Inn, Pocono Manor, Pa.

PENNSYLVANIA STATE COLLEGE, SCHOOL OF HOME ECONOMICS
Annual Spring Weekend, April 17-18, State College, Pa.

PHILADELPHIA TEXTILE INSTITUTE ALUMNI ASSOCIATION
52nd Annual Banquet, Feb 6, Warwick Hotel, Philadelphia, Pa.

SYNTHETIC ORGANIC CHEMICAL MANUFACTURERS ASSOCIATION OF THE UNITED STATES
Feb 11, March 11—all at the Hotel Commodore, New York; June 11-13 (Joint Outing with Manufacturing Chemists' Association at The Greenbrier, White Sulfur Springs, W Va.

TEXTILE RESEARCH INSTITUTE
1953 Annual Meeting, Nov 12-13.

REPRINTS OF TEST METHODS

For the convenience of those using only Part III of the 1952 Year Book, on Test Methods, reprints of this alone can be purchased from the Secretary, AATCC, Box 28, Lowell, Mass, for $1.00, postpaid.

The Late Jack Epelberg

Jack Epelberg, Councilor and Past Chairman of the Hudson-Mohawk Section, died suddenly on December 26. See obituary on page 92 of this issue.

South Central Section Meeting Dates for '53

The South Central Section has scheduled the following meeting dates for 1953:

Winter Meeting——February 28, Patten Hotel, Chattanooga, Tenn

Spring Meeting——May 23, Patten Hotel, Chattanooga, Tenn

Summer Outing——August 21-22, Chattanooga Golf & Country Club, Chattanooga, Tenn

Fall Meeting——December 5, Patten Hotel, Chattanooga, Tenn

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P L Meunier

(Dr Meunier is the author of the article "Dyes for 'Orlon' and Their Application," which appeared in the previous issue on page P39).

1952 Annual Convention——

CLOTHING AND CLIMATE FROM A PHYSIOLOGICAL POINT OF VIEW*

L P HERRINGTON

Dept of Public Health, Yale University and Director of Research, John B Pierce Foundation Lab of Hygiene, New Haven, Conn

An illustrated discussion of the properties of man as a heat machine and his range of adaptation to climatic stresses of heat, cold, radiation, and moisture. The recent quantification of these stresses by physiologists and biophysicists resulting in the stress classification of various climates and in the development of such concepts as the "clo" and "tog" units of clothing insulation is described. With this background, the bearing of more familiar physical characteristics of fabrics, such as weight, permeability, and hygroscopic character, is discussed in relation to the broad problem of adapting clothing to meet the physiological and comfort requirements of both general and special conditions of climatic use.

INTRODUCTION

AS AN environmental physiologist concerned with the effect of heat, light, sound, vibration, and other physical agents on optimal human life, I would like to bring into my discussion factors related to climate and clothing which touch the color interests of this group. However, the technology of clothing and climate stress is such that, beyond calling to your mind past experiences of blue January fingers and flushed July faces, I am going to assume that you all are properly saturated, color-wise, and will be content to add a little in the way of temperature to your experience.

It is rather a good plan to prepare a captive audience for what is to come. Hence, I should like to summarize briefly the primary points that will be discussed.

In the first few minutes we will review some of the properties of man as a heat machine, some of the correlations between physical and physiological measurements, and the thermal sensation of comfort.

Then we shall inspect briefly the biological costs of living as influenced by climate exposure and, in this connection, point up the role of clothing and animal insulation in reducing this stress and improving human health and comfort.

A third section of comments will deal with man's range of adaptation to climatic stress, and, in this discussion, we will give attention to the rather recent technical advances in improving the climatic adaptability of clothing as represented by the development and use of such units of clothing protection as the Clo and the Tog.

In the final section, the principal topics now represented by active research in determining the physiological suitability of fibers and fabrics will be discussed. Here we shall give principal consideration to the relation of clothing as worn to fabric and environmental properties affected by air movement, radiation factors, and fiber hydroscopic properties, concluding with a discussion of the human skin itself as a fabric, the first fabric of the human body.

PROPERTIES OF MAN AS A HEAT MACHINE

The total basal heat production of an adult male of average body size is near 70 kg cal/hr. If the strict rest and fast conditions to which these basal rates apply are altered to include the sitting posture, light activity such as reading, and a period of fast 2 to 3 hours in length rather than 8 to 10, the metabolic rate per M^2 rises to a value near 85 kg cal/hr for the average man. This level of heat production (near 100 watts per man) has been designated as the "met" by Gagge, Burton, and Bazett *(1)*, and has been widely applied in calculating the clothing insulation required by various combinations of human heat production and environmental temperature.

Physical activity is the primary factor responsible for elevating total heat production per man above the 100-watt level (85 kg cal/hr) noted above as a reasonable estimate for complete relaxation in the sitting posture.

This is not an academic fact for the clothing technologists, since a two- to five-fold variation in heat production in different occupations presents a major difficulty for standard clothing in an atmosphere which remains at the same general temperature.

The energy for this process is derived from food combustion within the body. Hence, it is possible to consider that human occupancy of confined spaces, or their enclosure in protective clothing, is analogous to occupancy of the space by multiple heat engines, consuming fuel, and producing heat and motion. A characteristic difference between the mechanical and the biological process, however, lies in the low temperature at which human combustion proceeds (near 98.6°F) and the elaborate and sensitive mechanism within the human body, which holds its internal operating temperature near to this fixed point despite large variations in heat production and wide swings in external temperature.

The reality of this thermal regulation and its efficiency, both of which are much affected by clothing insulation and its styling, may be illustrated by reference to Figure 1 and Table I. Figure 1 shows

* Presented at the Hotel Statler in Boston, Mass on Nov 6, 1952.

TABLE I

DIFFERENTIAL THERMAL BEHAVIOR OF HEATED MANNIKIN AND HUMAN SUBJECTS WHEN EXPOSED TO TEMPERATURES OF 77, 86, AND 95°F

Unclothed Heated Mannikin			*Unclothed Human Subjects*		
Air Temp °F	*Skin Temp °F*	*Internal Body Temp °F*	*Air Temp °F*	*Skin Temp °F*	*Internal Body Temp °F*
95	102.2	107.6	95	95.0	98.6
86	93.2	98.6	86	93.2	98.6
77	84.2	89.6	77	84.2	98.6

	Gradients °F			*Gradients °F*	
Air Temp °F	$T_S—T_A$	$T_B—T_S$	*Air Temp °F*	$T_S—T_A$	$T_B—T_S$
95	7.2	5.4	95	0	3.6
86	7.2	5.4	86	7.2	5.4
77	7.2	5.4	77	7.2	14.4

a copper replica of the human body. When filled with water and supplied with normal heat, the gradient of temperature from the internal water mass through the skin to the outside air in a room at 86°F is given in Table I. By regulation of the fluid circulation rate the gradients of heat loss established may be made quite similar to those found in a nude human subject at the comfortable and thermally neutral condition of 86°F. When the temperature of the environment is raised or lowered by 9°F, every step in the temperature gradient of the heated mannikin reflects in an exact manner the temperature change in the environment. If the human body responded to a change of ± 9°F in the environment in the same manner, the individual would be prostrated with the heat at 95°F, and rigid with cold, perhaps unconscious, at the 77°F condition. However, as one may see in Table I, this is not at all the case. The human data of this table indicate that the deep internal temperature is quite constant over this 10° range of environmental temperature. If we add to this primary thermoregulatory ability of the nude body the additional range conferred by voluntary choice of clothing and regulation of heat production through activity, the range of external temperature over which body temperature may be maintained near 98.6°F for limited periods extends at least from —40°F to 120°F. There is, however, a substantial physiological cost attached to such survival adjustments, and maximum human efficiency is preserved only in a narrow range from approximately 60°F to 80°F for the clothed subject.

The reason why the human body is able to react differently from the heated mannikin is very simple. On cold exposure, the insulation value of the naked skin may be greatly increased by withdrawing warm blood from the skin surface. This mechanism resembles the automobile's radiator thermostat, which, on a cold morning, will not circulate water in the engine unless a certain temperature is reached.

Under exposure to 95°F the human excels the heated model in remaining at a standard internal temperature primarily through physiological ability to sweat. This is an evaporative cooling device, which may use up to several quarts of water in an hour and produce a total cooling effect that compares favorably with the combined refrigerating capacity of several domestic refrigerators working in tandem.

We may now ask the question, "How does the human body accomplish this thermal adaptation"?

The primary element in human temperature regulation is a group of cells located by Ranson *(2)* in the hypothalamic area of the brain. This temperature-regulating center is directly sensitive to temperature. Because of its location and blood supply, it is constantly perfused by blood whose temperature is a representative sample of the thermal state of the important vital tissues and organs of the body. This center operates as a thermostat set normally at 98.6°F for resting levels of activity, but capable of resetting itself for higher levels as total heat production increases. In contrast with the usual mechanical thermostats, this biological temperature regulator initiates positive adjustments for excesses as well as deficiencies of temperature, and hence, in a gross sense, resembles the dual control of an air-conditioning system with both heater and cooler units under its control. Not only are the adjustments which this center may initiate to temperature stress influenced by the actual temperature of the cells that comprise the center, but, through its correlative function, it is also influenced by temperature events affecting the numerous warm and cold sensory receptors of the skin surface. Through such interconnections the center is sensitive both to the slow trend of the temperature of the internal body mass and to the sudden changes that may occur at the body surface. This gives the regulation what would be mechanically regarded as an anticipatory function and which you see advertised as a device to improve the comfort of stone or brick houses in regions with sudden temperature changes. The sensitivity of the skin, in a mechanical sense, is no surprise to a textile man. However, its thermal sensitivity is just as remarkable. It has been shown that the heat receptors in the skin are sensitive to changes as small as .036°F and the cold receptors, to changes as small as .072°F. There is no direct evidence as to the sensitivity of the heat regulator in the hypothalamus in man, but animal experiments of Ranson and Magoun indicate that this sensitivity is not great; that is, the regulator responds to changes of several degrees in blood temperature.

In order to measure the effects of air movement, radiation, relative humidity, and temperature as they affect scientific clothing requirements, it is necessary to construct man-sized calorimeters, capable of producing wide climate changes, and equipped to measure simultaneously the effect of these factors on both nude and clothed human beings.

Sooner or later handbooks of textile groups will have a section on the physio-

Figure 1

Electrically heated copper replica of the human body used in determining the insulation value in clo units of complete assemblies of clothing. Skin area, 20 square feet.

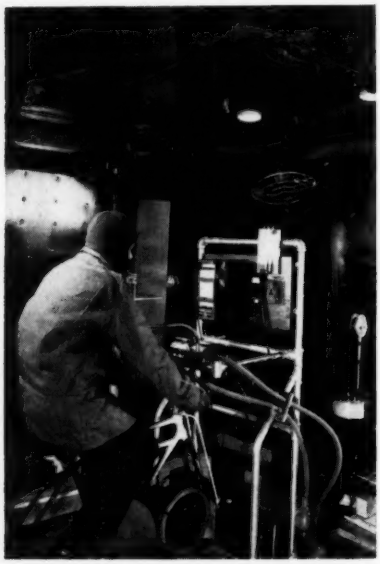


Figure 2

Wide-range climatic calorimeter with subject performing standard work under cool conditions. Technical arrangements permit temperatures between Arctic and Tropic range, and determinations of clothing and human reactions to humidity, radiation, and wind velocity. Black globe in ceiling registers net thermal stress of the environment. (Pierce Foundation.)

logical properties of clothing. The data for these sections will come from calorimeters of the type shown in Figure 2.

This human subject is having evaporative heat loss determined in the clothed condition. In front of him is an electric bicycle for work experiments. In both nude and clothed condition, all elements such as body, skin temperature, sweat loss, heat production, clothing insulation value, and moisture gain may be measured over a climatic range from —40 to 180°F with high and low air velocities. In addition, the reflective aluminum walls of the calorimeter contain infrared and solar-type radiation units, which control the important factor of heat radiation.

In textbooks, such as *Heat Regulation and the Science of Clothing* (Newburgh, Editor, W B Saunders Company, 1949), a very large portion of the physiological data important for clothing technology has been obtained from human exposure calorimeters of this kind.

CLOTHING INSULATION IN RELATION TO THE BIOLOGICAL COST OF LIVING

If an experimental animal such as the albino rat lives at three different temperatures for his life time, there is a considerable effect on the average life time.

TABLE II
HEAT PRODUCTION/M²/24 HOURS

Cage Temp °F	Kg Calories
95	1000
83	650
59	1000

In Table II a substantial reason is indicated for this. At 82 to 83°F the basal total heat production of the rat is near 650 Kg Cal/M²/24 hours. At 95°F it is near 1000, and likewise at 58°-59°F it is near 1000 Calories for each square meter of surface area per day. One way of putting this is to say that the cost of living for the rat is least near this animal's point of thermal comfort. It has been noted in many laboratories that, at least in the case of the cold exposure, this extra metabolic cost of living reduces the average life time by an amount between one-half and one-third of the normal life span. It might be added that the cold stressed animals are not unhealthy, they merely exhaust their capacity for metabolizing sooner because of higher rates of combustion.

Clothing enters into this physiological stress in a direct manner. Animal pelts are physiologically produced textiles. Their function, particularly important in the small animals, is to reduce heat, and, in a measure, to conserve energy. When an animal uses metabolic energy to grow hair, it is a splendid example of a good business transaction. A sheep growing 7 pounds of wool may pay for this production, perhaps, 25,000 to 30,000 Calories. If the sheep did not grow the insulation, this same energy cost, appearing as animal heat in zero weather, might keep him as warm as the fleeced animals for several weeks. Probably the net energy gain for this animal in producing insulation rather than extra heat, would amount to 200 to 300 per cent in a single cold season. Of course, one might add that the sheep has incorporated human friends who approve of his choice in the matter.

We do not know for man and the larger animals the direct life-conserving properties of insulation. However, no reasonable man would doubt that clothing and the insulation of habitations are prime factors in adjusting man to the wide variety of climates he has conquered, and the life conservative properties of clothing and adequate housing are recognized by the medical authorities of every civilized nation.

Functional clothing designed to minimize the energy stresses of cold environments and to lessen the dehydration and radiation stresses of tropical environments have, in addition, a very large and well-appreciated effect on subjective comfort. Functional clothing also contributes indirectly to better human performance in many situations. One of these is in relation to temperature-correlated accidents. Human physical accidents and errors of perception (clerical, accounting, figure discrimination) have many causes, but one important cause is awkwardness or restlessness related to cold stress, and failure of alertness due to heat stress. In Figure 3, the clear role of temperature in determining the number of accidents in a British munitions factory is obvious. Both below and above the 66-67°F optimum temperature for light work, accidents increased notably. In the difference between the curves for men and women, the influence of traditional as opposed to functional clothing may be seen. The women in this factory wore about 4 pounds of clothing in contrast to 6 to 7

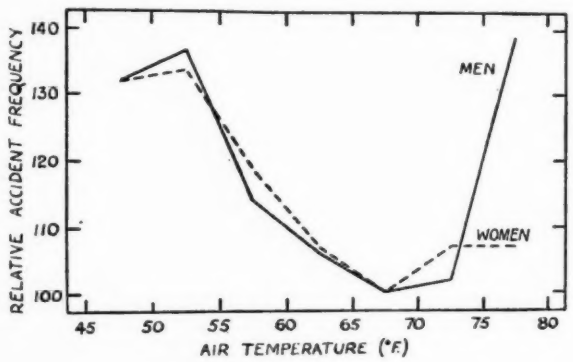


Figure 3

Illustration of Effect of working-environment temperature on incidence of accidents in light factory work (munitions) and less susceptibility of women in warm zone because of differential clothing. (From English studies by Osborne, Vernon, and Muscio, Rep Indust Fatigue Res Bd, London, No. 19.)

Figure 4

Subject exercising in calorimeter under warm conditions, wearing equivalent of 0.1 clo insulation. Rate of work and body-heat production are monitored by observing chart line on center instrument, which records electrical energy generated by the rider.

pounds for men. In addition, feminine clothing styles have a greater range of variation in degree of personally determined thermal effect, for standard dress, than is the case with male attire. As a compound of these factors we note that, while both men and women showed increased accidents from cold stress below the temperature optimum of 67°F, the lighter weight and greater adjustability of women's clothing greatly reduced thermally associated accident rates in the warm and hot environments.

QUANTIFICATION OF CLOTHING IN RELATION TO CLIMATIC STRESS

In reaction to heat, the physiological units of superior clothing performance are degrees of reduction in average skin temperature for the superior version of two or more competitive assemblies in the climate range above 75°F, and reductions in grams of sweat secreted at the skin surface. In addition to these criteria, the clothing assembly holding in its fabrics the least amount of residual water or fiber moisture at the end of a heat-stress period is functionally conservative of physiological energy.

At temperatures below 75°F the thermal-insulation factor per unit of weight becomes the principal criterion of physiological acceptability.

In both of these areas the development of scientific measures of excellence was preceded by primitive recognition of the functional role of clothing. In certain of the Pacific islands with Melanesian populations, natives unacquainted with thermometers rate hot weather by describing the day as a one-undress, two-undress, or three-undress day, referring by these terms to the number of daily baths they take to cool the body and the number of times they dry the sarong and its masculine counterpart.

In the hinterland of China a similar language custom has existed for centuries with respect to cold stress. Winter dress in this region consists in the addition of multiple layers of coverall-like garments. In native dialect these are called "suits". By use of this clothing thermometer, the native Chinese refers to a warm July day as a "no-suit" day, and to a January blizzard as a "twelve-suit" day. As an interesting validation of human sensation sans instrumentation, we find that 12 of these light Chinese suits are about equal to 4 clo of our cold weather clothing, a value generally recognized as the maximum compatible with efficient movement.

Fortunately for the American clothing technologists, these picturesque primitive terms now have a technical meaning and are evaluated by definite methods.

In Figure 4 a subject is shown exercising in the climatic colorimeter with a thermal protection which you might guess is reasonably close to the feminine goal of Zero clo. In fact, technically the swimming suit shown has a clo value of about 0.1 of a clo. The clo unit is not restricted to clothing but may be used to assess the combined effects of clothing and other equipment.

In Figure 5, the young man whose sleeping bag has been placed on a platform of ice in the calorimeter room is wearing a total of 6 clo while sleeping, 5 of which are due to the sleeping bag. One might add here that the bag is on the ice because, at 25°F, the ice surface is nearly 20° warmer than the aluminum floor of the calorimeter, which is at 6°F.

For engineers, we may say that, in resistance terms, 1 clo unit is equal to

$$0.88 \ \frac{^\circ F}{BTU/hr/Sq\ Ft}$$

Perhaps something is added to the sensory appreciation of this unit by the following example. With low air movement and moderate humidity, the resting nude subject is comfortable at 86°F. One clo of insulation is required to maintain the same degree of comfort when the air temperature is dropped 16°F. Extending this analogy, one can say that two clo is the clothing sufficient for comfort at 86°-32° or 54°F, three clo that sufficient for 86°-48° or 38°F, and so on, it being understood that air movement and heat production remain in agreement with the formal definition.

Figure 5

Subject wearing 1-clo basic insulation and 5-clo sleeping-bag protection. Measurement of distribution of body skin and fabric temperatures during 8-hour shift on ice surface (25°F) in Calorimeter at 6°F.

It is probably obvious that one clo is very nearly the insulation provided by normal male clothing. This is intentional and provides a valuable experience correlation for the unit. The usefulness of the clo concept and of its British translation the "tog" unit in the broad climatic problem of clothing is connected with the fact that maps are now available for various areas of the world in which the human clo requirement for the seasons is printed directly on the map. Perhaps it is permissible to say here that the general recognition of the need for assessing the physiological properties of clothing has helped to put the textile industry "on the map".

CURRENT PROBLEMS ON THE PHYSIOLOGICAL ACCEPTABILITY OF FIBERS AND FABRICS

THE USE OF REFLECTIVE INSULATION———Recently we have had renewed interest and trial of infrared reflective materials as insulation in clothing. The potential advantage in substituting flexible infrared reflecting surfaces for bulky air-entrapping insulation is weight reduction. I have recently expressed myself publicly on some of the common difficulties with this subject, and these remarks are again in place here *(4)*.

In common experience our notions of radiation and reflection are associated with visible objects and radiation wave lengths characteristic of the sun and incandescent lamps. Heat radiation from objects at ordinary temperatures is long-

wave, or infrared, radiation and is invisible. It may, of course, be felt by the skin, as in the case of a warm wall.

Radiant energy may be reflected. However, a good reflector for energy from a high-temperature source is not necessarily a good reflector for the dark heat from our ordinary surroundings. This point has led to some general misunderstanding in the application of reflective insulation to clothing.

Since we associate *visible* reflection with the word "reflection", it is often assumed that any shiny-surfaced material will provide reflective insulation for dark or invisible infrared. The misunderstanding has been furthered by the fact that by chance one of the most common reflectors for high-temperature sources, aluminum surfaces, is also a good reflector for invisible infra-red radiation under certain circumstances. These circumstances are the requirement that the aluminum surface either be uncoated for long-wave infrared insulation or be so thinly coated that the absorbing effect of the organic materials is unimportant.

It is quite unsafe to estimate the long-infrared reflecting character of an aluminized fabric by giving regard to its visible appearance. Technical measurements of long-infrared reflectance are the sole acceptable criteria of the adaptability of such fabrics to insulation uses.

When spacings of 0.1 to 0.7 inches are used between the plates of a fabric-heat-conductance-measuring apparatus, gains of approximately 15 per cent can be realized by facing the terminal plates with aluminum foil of 0.95 reflectance when the intervening space is filled to a low density with other insulating materials.

When narrow spaces of the order of 0.1 to 0.2 of an inch are used without a filler, gains of the order of 40 per cent are theoretically possible, provided you are ingenious enough to maintain this separation rather exactly in a flexible garment without introducing cumbersome spacers.

In order to realize the larger gain in lighter constructions, means would have to be found of preventing contact of the opposed metallized surfaces or any substantial intervening area of fabric or filler. In addition, the fabric surfaces would have to exhibit tested reflectances near 0.95. For applications requiring very low over-all conductance, the larger gain cannot be realized for physical reasons related to the nature of the radiation exchange process.

It would not be in order to discard the utility of technically improved reflective fabrics in protective clothing or related applications. A flexible and durable fabric of 0.90 reflectance in the long infrared would have many applications. At the present moment such fabrics as have been developed seem to have their most direct application when used in connection with fire-fighting equipment. Here the requirements for efficient and useful insulation performance is less exacting, since the radiation diverted from the body by the reflective shield is different in character from body heat radiation.

Table III, taken from studies made by A C Burton and reported to the National Research Council, give the quantitative aspect of the application which currently appears most feasible, namely, the combination of two reflecting layers bounding a filled air space. It should be emphasized, however, that in this field all is not "silver that shines". In order to attain this added insulation, the bounding surfaces must be proven to be reflective for invisible infrared from temperature sources near the temperature of the human body.

Figure 6

Subject in metal chamber designed for extremely rapid shifts of relative humidity without alteration of general temperature of exposure. Hydration and temperature changes on skin and in clothing are measured in connection with shifts such as 10 to 90 per cent at temperatures between 60 and 90°F.

TABLE III*

THERMAL INSULATION OF "FILLED" AIR SPACES

Insulation in Clo Units

Thickness, inches	*with blackened plates*	*with reflecting plates*	*% Increase Due to Reflection*
0.1	0.43	0.50	16.3
0.2	0.76	0.88	15.8
0.3	1.04	1.19	14.4
0.4	1.27	1.44	13.4
0.5	1.48	1.70	14.8
0.6	1.67	1.93	15.6
0.7	1.86	2.14	15.1
		Average	15.1

* A C Burton, National Research Council Report.

HYDROSCOPIC AND WICKING ACTIONS OF CLOTHING

Primarily as a result of the relatively recent appearance of many new fibers with different physical and hydroscopic properties, civil and military scientists interested in the physiological suitability of fabrics have taken a renewed interest in the water- and vapor-transport problems of clothing. In this connection, the question most frequently raised is the relative physiological effect of fibers of various grades of moisture-regain capacity.

In order to avoid the dilution of an important current conclusion on this problem by detailed remarks it is desirable to state, first, the principal experimental view of this matter in a brief manner.

The major portion of past and current work on differentially clothed human subjects directs attention to fabric geometry, as the most important basic element in varying the thermal character and moisture-transport acceptability of clothing assemblies. The reasons for this are many and varied, but a principal point, in so far as the influence of regain capacity is concerned, may be quickly appreciated.

For comfortable climatic conditions not involving heavy labor, the hourly moisture transport of a clothing assembly is seldom greater than 30 grams an hour. Under conditions of even slight bodily activity, 20 to 25 per cent of this load short-circuits the clothing barrier through vent action. Under average conditions of temperature and humidity, the residual regain capacity of a clothing assembly is substantially larger than the hourly moisture-transport requirement, for assemblies composed of either low- or high-regain materials.

The second important class of use is that in which exercise and heat combine to present, at the skin surface, moisture-transport loads of one to several hundred grams per hr. Under these conditions, the total residual-regain capacities of all fibers, whether of low or high hydroscopic character, are grossly exceeded.

A technical way of restating this is to say that *the total moisture-capacity differences in grams per pound of designed clothing for the array of current synthetics and naturals is very small with respect to the range of physiological loads.* In this sense all fibers meeting other general requirements are potentially adequate, in proper fabric designs, for normal dress conditions with respect to regain properties, and for heavy work conditions, the ideal fiber is not currently in existence. All important human subject work on this latter problem indicates that the conditions of human use, which imposes a high hourly water-transport load, will be improved by attention primarily to fabric-

(concluded on page P69)

1952 *Intersectional Contest*——

TEXTILE ODORS AND DEODORANTS*

NORTHERN NEW ENGLAND SECTION

COMMITTEE

Alan A Claflin, *Chairman and Speaker*
Kenneth L Dorman
Arthur Gallagher
John L Patti

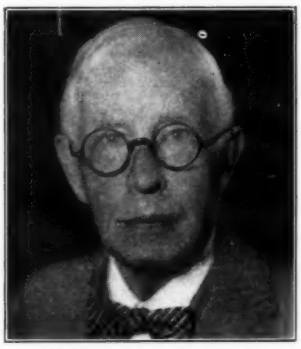
INTRODUCTION

SENTIENT man is endowed with, or has developed, five senses. Hearing and seeing are definite and definable, sounds and sights are measurable and reproducible. Acoustics and optics are exact sciences. Despite the fact that one man may have an ear for music and another lack it, or the dyer's eye not agree with the spectrophotometer, the truth is ascertainable, the individual is subservient to the instrument.

Feeling, tasting, and smelling are different. Of course in a gross sense, mechanics determines our feelings; we early learn a rock is harder than our head, or a baseball than our eye. But when a woman representative of a converter claims a difference in hand, how is it measurable? When a customer complains the fabric of synthetic fibers does not permit his skin to breathe, is it actuality or imagination? Progress, however, is and will be made in this field because basically the physics are known.

With tasting and smelling, we approach an area of the vague and unknown. Fortunately, as textile chemists we are not concerned with the gustatory sense of taste. While we frequently chew the rag, we do not care what the rag tastes like. Now smell is *different,* at any moment the textile chemist may have a problem involving odor. It may be concerning the creation or abatement of a nuisance. More likely it involves the rancidity of a finishing oil, or the decomposition of a shrinkage-control resin. In any case, it behooves the chemist to inform himself so far as possible in the realm of perfumes, odors, smells and stenches. You note the order in which these terms are given, and this is perhaps as it should be, as far more than one is apt to appreciate the distinction between them is rather quantitative than qualitative.

* Presented for the Northern New England Section by Alan A Claflin at the Statler Hotel in Boston on Nov 8, 1952.



Alan A Claflin

The committee attempts to clarify the subject of textile odors and deodorants, to distinguish and demonstrate what is probable from what is imaginary or absolutely not so. The paper is based partly on many years of observation and partly on some current and continuing laboratory work.

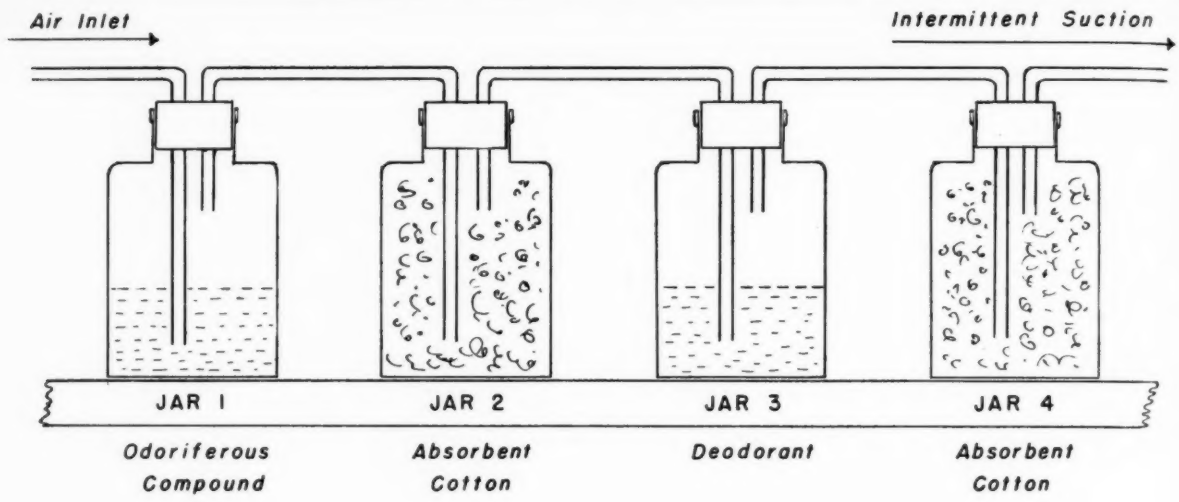
LITERATURE SCANTY —— There is some literature on this subject, particularly on perfume, but on the sense of smell itself there is much vagueness. That the olfactory nerves are situated at the base of the nose is known to everybody, that they are embedded in organoleptic membrane sounds erudite, but adds little. In some insects, at least, the nerves are apparently in the antenna. These olfactory nerves are astonishingly sensitive to certain vapors. There may be some question as to the accuracy or exactness of this sensitivity, but none about its delicacy.

One part of Rhodamine B in 4,000,000 parts of water, I understand, is seeable, while one part of geraniol in forty million of air is smellable. I am reporting these observations second hand, because that is the way it is done in the literature of smells. There is, as I have said, some literature, not too much, but of such literature a surprising percentage, in my opinion, may be defined as surmisable, mythical and pure bunk.

PURPOSE OF THE PAPER——This paper is an attempt at clarification of the subject, to distinguish and demonstrate what is provable from what is imaginary or absolutely not so. It is based partly on many years of observation and partly on some current and continuing laboratory work.

The sense of smell varies tremendously with the individual, probably far more than tone deafness or color blindness, but unless cultivated and trained is surprisingly nondiscriminatory. Sulfur dioxide and chlorine to the chemist are antithetic; to the ordinary workman or lay visitor at the heavy chemical plant, they are indistinguishable. He notes the irritating quality, but nothing more.

As stated, to affect the olfactory nerves a substance must be in the gaseous or vapor phase. It may be acid, ammoniacal, alcohol, ether or ester or nonionic, water-soluble or insoluble. In regard to this latter statement, it is probable that, considering the extreme dilution at which they are detectable, all odoriferous substances may be considered water-soluble. The perfumes are in general aldehydes, alcohols, esters, or ethers; the stenches, acids or amines. While odors are volatile, they have an extreme tendency to be adsorbed by textile fabrics. This is particularly true of the stenches. A suit of clothes exposed to dilute butyric acid vapor smelled disgustingly strong after being kept in a locker for three years, and many a woman has regretted the persistency with which her Alaskan-sable boa betrayed the ancestry of its components, especially when slightly dampened by snow. By themselves



the perfumes do not have this permanency, but it is achieved by augmenting them with what are known as fixatives. In some respects fixatives resemble plasticizers in the resin industry. They are solvents and have some volatility, frequently they have somewhat objectionable odors, eg, ambergris and civet, but these are subordinated to the more volatile etherial odors.

MASKING UNPLEASANT ODORS— This property of the less volatile, more permanent objectionable odors of being subordinated to the more volatile pleasant odors should be emphasized, as it is the principle on which most commercial deodorants and so-called air refreshers are based. Unfortunately, the olfactory nerves are readily saturated with a given odor, and if one smells some jasmine or other popular air refresher odorant just before he enters a movie theatre, he will smell the previous audience rather than the refresher. By the same procedure one may determine the constituents of a mixture of solvents, by first saturating the nose with the most obvious and then the next. Up to four or five ingredients may thus be recognized. By sniffing the straight benzaldehyde first, one may detect the rancidity of a tallow that has been temporarily masked by oil of mirbane. Masking, while it may sometimes serve the same purpose, is not true deodorizing.

Deodorization can be effected by adsorption by activated carbons and clays or by actual destruction of the odoriferous substance by chemical combination. Activation of a carbon or a clay is simply the driving out of occluded gases by heat. At one time so-called ozonizers had some vogue as deodorizers. It was claimed a high-voltage discharge of static electricity produced ozone, which was said to oxidize the odoriferous substance. Under certain conditions these worked but they were relatively expensive, and the oxidizing agents are nitrogen oxides, not ozone. An arrangement by which nitric acid is dropped on a hot plate would have accomplished the result at a tithe of the cost. More effective chemical controls are the neutralization of odoriferous acids, like butyric and caproic by ammonia vapors, the condensation of amines by aldehyde vapors (formaldehyde and acetaldehyde), the combination of sulfides with heavy metal, eg, lead, copper, silver and mercury.

VOGUE OF CHLOROPHYLL —— Recently chlorophyll has achieved great publicity and notoriety as the wonder-compound, the marvelous molecule that somehow miraculously adsorbs, prevents or destroys all odors. Now, we as chemists should be the last to decry the importance of chlorophyll. Animal life on this planet, did not, could not exist, without this complicated heterocyclic arrangement of carbon, hydrogen, oxygen, nitrogen and magnesium atoms. Should chlorophyll disappear, so would mankind, animal and vegetable life. Only some marine life would exist, as it did before chlorophyll came into being. Yet the value of chlorophyll as a deodorant may be questioned. As a speaker said at the recent meeting of the American Pharmaceutical Association, "The time has come to take chlorophyll from the advertising man and turn it over to the chemists." That is why we started our experimental work, that is why this paper is written.

EXPERIMENTAL

APPARATUS DEVELOPED —— Our equipment is simple: four wide-mouth bottles or flasks in line connected by glass tubing to a suction line. The connection is such that air is successively drawn through the bottles, entering at the top and drawn from the bottom. To ensure longer contact with the contents of the bottles, the suction is intermittent, about the frequency of ordinary respiration. Bottle #1 contains an odoriferous substance, #2 carded cotton, #3 the deodorizer, #4 carded cotton. After the draught has been running long enough to give bottle #2 a reasonably strong and persistent odor, this time determined by experiment, bottles 2 and 4 are disconnected and stoppered. Meanwhile,

TABLE I
ABSORPTION AND DEODORIZATION OF ODORS

Bottle 1 with Odoriferous Substance Original Odor	*Bottle 2 with Fiber Absorbent* Residual Odor*	*Bottle 4 with Same Fiber Absorbent* Residual Odor*
Citral	medium strong	same
Texodor (floral)	medium strong	same
Texodor (vanillin)	weak	same
Pine oil	very strong	same
Trimethylamine	weak	faint
Pyridine	weak	faint
Oil of garlic	very strong	very strong
Cheese (butyric)	strong	faint—butyric odor removed
Butyric acid	strong	butyric odor removed

Bottle 3 with Deodorizer: 100 mg chlorophyllin soda-copper

* Fiber Absorbents: 1st series, cotton; 2nd series, wool; 3rd series, nylon staple. These three fibers showed no discernible difference.

TABLE II
ABSORPTION AND DEODORIZATION OF ODORS

Bottle 1 with Odoriferous Substance Original Odor	*Bottle 2 with Fiber Absorbent* Residual Odor*	*Bottle 4 with Same Fiber Absorbent* Residual Odor*
Citral	medium strong	same
Texodor (floral)	rather weak	same
Texodor (vanillin)	rather weak	same
Pine oil	very strong	same
Trimethylamine	weak	faint
Pyridine	weak	faint
Oil of garlic	very strong	very strong
Cheese (butyric)	strong	very faint—butyric odor removed
Butyric acid		butyric odor removed

Bottle 3 with Deodorizer: 100 mg chlorophyllin soda-copper plus 50 mg formaldehyde tech soln.

* Fiber Absorbent: 4th series, cotton; 5th series, wool; 6th series, nylon staple. These three fibers showed no discernible difference.

fresh odoriferous substance is put in bottle #1 and a new deodoriferous substance is put in bottle #1 and a new deodorizer in bottle #3. Since this is a virgin field, the number of permutations and combinations is vast. Gradually they can be classified. After standing some hours, bottles 2 and 4 may be sniffed. Of course sniffing #4 first as the stronger odor always inhibits the detection of a weaker odor of the same kind. If bottle #4 smells nearly as strongly as #2, it would seem one can safely say the deodorizer is not efficient. While one cannot weigh or photograph the results, one can reseal the bottle and let the next sniffing jurist record his opinion. Thus far we have devoted our attention primarily to chlorophyll and its various formulations. We have tabulated our most characteristic results. We have some bottles for the inquisitive to smell. Perhaps our reasoning is faulty, or our procedure too rudimentary, or for a dozen other reasons our findings are inaccurate, but at least we hope we have made a beginning in trying experimentally to determine what is fact and what is fiction in the realm of odors. Our results are presented in Tables I and II.

Clothing and Climate—

(Concluded from page P66)

design factors.

Important physiological and biophysical work on this problem by Andreen, Gibson, and Wetmore *(5)* will appear in an issue of the *Textile Research Journal*, and other civil and military groups have data which will soon be in print.

These conclusions are perhaps not surprising if we remember that the human skin is the first fabric in the clothing assembly, and that, in order to facilitate maximum evaporation of water, the skin surface is normally water-resistant.

The human skin surface may be studied from exactly the same standpoint as that from which we study fabric properties.

In Figure 6, a special humidity cabinet introduced into the climatic calorimeter at my institution is illustrated. Subjects placed in this special enclosure with proper recording apparatus, may be subjected to rapid and wide range humidity changes within a period of 1 to 2 minutes, while still preserving the climate control of the general calorimeter space. Using these methods, the thermal insulation of the skin, its regain value, and rapidity of response to moisture load may be reliably measured.

Experiences with the biophysical properties of human skin and clothing have convinced us that the ideal fabric should have a good number of the properties of human skin, since fabrics are, in effect, second skins, operating either to oppose or facilitate certain normal biophysical skin properties.

Perhaps by way of conclusion, we might list here some of the biological properties that would be desirable in ideal fabrics:

A) Such fabrics should be able to vary their insulation as a function of temperature by at least two-thirds of a clo unit. The true skin, by regulating blood flow to the surface, can vary its physical insulation value by an amount equal to approximately 10°F of environmental heat change. A combination of skin and fabric with this property would permit a man to be equally comfortable between 60° and 80°F without changing his clothing. Aside from improving the sense of comfort of a crowded convention hall, it may be assumed that other rewards would be quite tangible for the designer of such a fabric.

B) As a second property, we might propose that the ideal fabric should resemble the skin in the latter's peculiar ability to transfer large amounts of water before becoming sufficiently wet to change its resiliency and strength. Although the skin has a water content, it may be almost instantly dried to an acceptable condition with normal properties of elasticity and resilience.

C) Finally, we might propose that, in contact properties, the ideal fabric would do well to imitate the complex of physical properties which insures, in its contact with external surfaces, a positive grip, and yet at opposed surfaces has a frictional component which is below the threshold for irritation.

In concluding may I say that I have not forgotten that there are gentlemen here who may have to color this Frankenstein fabric, and others who may have to weave it. For these I offer my sympathy in the trials of these future problems, but with the happy thought that this ideal fabric may not be so much of a burden for those who purvey it to a waiting public.

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FROM PHILOSOPHER'S TOY TO INDUSTRY'S HEADACHE

—THE STORY OF STATIC ELECTRICITY

SIDNEY M EDELSTEIN

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S M Edelstein

HISTORY contains many accounts of the effect of static electricity on textiles long before the invention of synthetic fibers. Much of the work being done today on static electricity is either a duplication or has its roots in the work of the great scientific masters of the past. Perhaps a look into the past of the science of static electricity may ease our way into the future. At least, it should make this path seem familiar and interesting.

In ancient mythology there is the story of a fabulous bird, the Phoenix. After living for hundreds of years, this bird made itself a nest in which it died by setting fire to the nest and burning itself alive. From its ashes there came forth another Phoenix, a perfect replica of its Father, to continue the same pattern of life.

The science of static electricity is like such a bird. This science also developed and lived for hundreds of years only to die in the fire of disinterest.* The new man-made plastics and fibers have again caused a wave of interest in static electricity, and have called forth a new Phoenix, for the ideas and principles which we use today are simply the old ones of the past.

Our story of static electricity is the story of all electricity for over 2,000 years, for it is only in comparatively recent times that electricity became "dynamic." To conjure up all the men who helped to develop the science and all the ideas and discoveries which fill its history is impossible in our short time. We shall examine those discoveries which are the basic corner stones in the development of the science of static electricity. We shall meet some of the men whose names are most closely connected with these discoveries. We shall neglect much——not because of lack of interest but because of lack of time.

THE FIRST OBSERVATION OF STATIC ELECTRICITY

The history of philosophy and science contains no earlier observation than that "yellow amber when rubbed has the power of attracting light bodies." Our history of static electricity thus starts with the very beginning of philosophy and science, with Thales of Miletus, the Father of Ionic philosophy, and with the oldest of resins, amber, the Tears of the Heliades, the elektron of the Greeks. Today we know that amber is a fossilized resin exuded millions of years ago from an extinct variety of pine tree. It is found widely distributed over the earth.

To the ancients, however, amber was something more. It was highly valued as a gem and to it were attributed mysterious and occult powers. In fact, it was the most important gem known to the ancient world and for ages was a powerful factor in the trade between widely separated peoples. Often in the past, Sicilian amber sold at a price far beyond the price of diamonds.

Opinions as to the origin of amber have been contradictory and conflicting perhaps because of the fact that the Phoenicians, the earliest amber merchants, were not inclined to disclose to the Greeks the source of their valuable merchandise.

While we find Theophrastus writing 300 years before Christ that "amber is a stone which is dug out of the earth of Liguria," the ancient Greeks gave more credit to the myth perpetrated by the Phoenicians that amber was the "Tears of the Heliades." The Heliades were the poplar trees into which the three sisters of Phaeton had been transformed by Jupiter. They stood through all of time shedding tears of amber into the stream which flowed by their brother's tomb.

Just as obscure is the origin of the first observations of amber's attraction for particles of straw and chaff when rubbed. That this knowledge of amber's attractive power goes back to the dim past is seen in the very names given to amber in the ancient languages. For example, in Syria they called amber Haparga, which means "attracting with force" or "clutching." In Persian they call amber Karuba, this word signifying "capable of attracting straw."

It is to Thales of Miletus, who lived about 600 years before Christ, however, that the ancient historians, Aristotle and Plutarch, attributed the first electrical observation, the observation that amber when rubbed attracts bits of chaff and straw.

Thales was the leader of the Ionic school of philosophy, before which school there was no philosophy or science. Thales, in fact, has been called the father of science. He learned geometry in Egypt and laid the foundations for the science of the geometry of lines. He was the first man to predict with accuracy an eclipse of the sun. He was a merchant, engineer and astronomer. Now Thales only noted the attraction of amber for small particles of various materials and remarked upon it. He did not recognize that the particles also had an attraction for the amber. He did not recognize electrostatic repulsion and was ignorant of the fact that many other substances also had the power of attraction when rubbed. Nevertheless, by noting the electric attraction and theorizing about it and by calling it to the attention of others as something important and mysterious, Thales forged the first link in the great chain of scientific thought and investigation which reaches from the distant past to the very present *(1), (2)*.

QUEEN ELIZABETH'S PHYSICIAN THE FIRST ELECTRICIAN

We now cross a span of some 2,000 years without finding anything new in our story of electricity until we arrive in England at the end of the 16th century during the reign of Elizabeth, that strong and wilful Queen under whose rule great literary masterpieces were written, frontiers in the new world were conquered, and the Spanish Armada destroyed. It was Queen Elizabeth's own personal physician,

* Presented at the Hotel Statler in Boston, Mass on November 7, 1952.

Figure 1
William Gilbert

William Gilbert, who pointed out new frontiers in science, and because of his work in electricity is still known to us as the Father of electricity.

Only a few of the facts are known about William Gilbert's life and practically no relics remain. There are no contemporary portraits and no manuscripts. His one legacy to posterity, however, is his great book, "On The Magnet", published in 1600, which contains the results of his many years of work on magnetism and electricity.

William Gilbert was born in Colchester in England in 1540 and died in London in 1603. Nothing is known of his boyhood. Possessing an MD degree from Cambridge, he was successful as a physician, had the highest respect of his fellow doctors, and was appointed personal physician to Queen Elizabeth, whom he attended in her last illness *(3)*.

All that Gilbert wrote on electricity is interpolated in the second book of his volume "On The Magnet." This short chapter, however, presented many new facts, many new ideas and many new methods in electricity. In fact, it was the first scientific treatise on electricity *(4)*.

Prior to Gilbert only two electrical phenomena were known. These were the attraction of amber after rubbing for bits of chaff, and a similar property held by jet, a kind of hard coal. He submitted these phenomena to scientific experiments and by means of an electroscope which he invented, disproved the idea that this "magical" property of attraction was possessed only by amber and jet.

He showed that, besides amber and jet, such substances as diamond, sapphire, sulfur, mastic, sealing wax, resins and many other materials had this attractive power. He also pointed out that there were many substances, such as pearl, marble, gold, silver, copper and iron, which did not show the attractive power after rubbing. He gave the name of electrics to those substances that developed the attractive power after rubbing and the name of anelectrics or nonelectrics to those substances that did not. He showed that the attraction exercised by electrics was not limited to mere straw or chaff, but that all metals and woods, as well as stones and earth, were attracted. He was the first to find out that oil, water and other liquids could be attracted by the electric force and he noted that moisture in the air as well as on the surface of materials affected their electrical properties. Finally, he showed that magnetic attraction and electrical attraction were completely different phenomena.

Peculiarly enough, however, while Gilbert relied upon experiment and did not readily accept the statements of the ancient writers, he did hold certain ideas concerning electrical attraction which were false. He insisted that electrical attraction was a one-sided and not a mutual force, and he denied the existence of electrical repulsion, although he clearly recognized magnetic attraction as mutual *(5)*.

It remained for another illustrious English scientist, Robert Boyle, some 75 years later to carry on electrical studies in the tradition of William Gilbert. He made use of the latter's correct observations and corrected the few wrong ones. It was Robert Boyle who showed that electrical attractions were mutual and that this electrical attraction could exist in a vacuum,

GVILIELMI GIL-
BERTI COLCESTREN-
SIS, MEDICI LONDI-
NENSIS,

DE MAGNETE, MAGNETI-
CISQVE CORPORIBVS, ET DE MAG-
no magnete tellure; Physiologia noua,
plurimis & argumentis, & experimentis demonstrata.

LONDINI
EXCVDEBAT PETRVS SHORT ANNO
MDC:

Figure 2
Title page of the rare first edition of Gilbert's De Magnete published in 1600

Figure 3
Otto von Guericke

air being necessary for its propagation *(6)*.

THE STATIC GENERATOR GENERATES FURTHER INTEREST IN STATIC ELECTRICITY

In the advancement of any branch of physical science there comes a point where the advance slows until means are at hand for readily producing at will and in fair quantity that force which is being studied. This was no less true in the case of static electricity. For thousands of years this electric force could be made weakly manifest by rubbing amber in the hand, and later by rubbing glass with the hand or with fur. While this small amount of electricity produced in amber or glass was sufficient for determining some of the first principles of electricity, a greater quantity of this force was needed before many of the great principles of electrical science could be understood. Such phenomena as electrical repulsion, the development of an electric charge by induction and many others required a much greater electrical force to become unveiled.

Thus, the invention of the first machine for producing static electricity by Otto Von Guericke in the last half of the 17th century marked a milestone in electrical science. Von Guericke was a German physicist and the Burgomaster of Magdesburg. He is equally well known for his invention of the air pump as well as for the experiment known to every school boy, of the Magdesburg hemispheres. It was Von Guericke who proved that light could pass through empty space and that sound required a medium such as air for propagation *(1)*.

It is not surprising that when a man of Von Guericke's mental powers turned to electrical studies, he produced so important a thing as the "static generator."

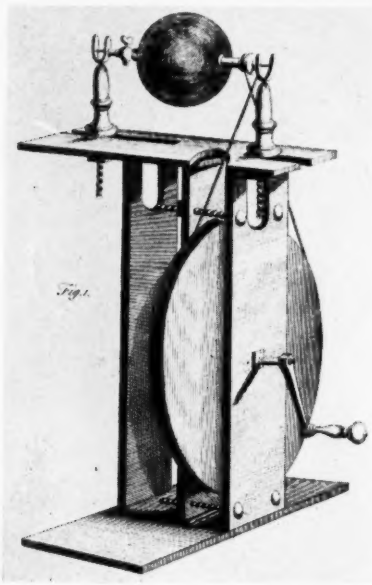


Figure 4
A 17th century static generating machine of Hauksbee

Von Guericke's machine was simple in conception and in operation. He simply mounted a sulfur globe on a spindle which was turned by a handle, and using his hand for a rubber, he drew sparks from the globe. In Von Guericke's words, the sulfur globe was "about the size of the head of an infant," and it was made by "pouring melted sulfur into a glass vial of spherical form which was broken after the sulfur had solidified."

With this machine Von Guericke made many observations and several were important contributions to electrical science. He clearly recognized the phenomenon of electrical repulsion as one day he chased a feather about his room with the electrified sulfur globe. On another occasion he recognized the principle of electrical induction or the electrification of neighboring bodies without actual contact, when a thread suspended near his sulfur globe became electrified without actual contact and was repelled as he brought his finger near *(7)*.

For almost a hundred years after the invention of Guericke's machine, improvements and changes in the instrument were made by many others. About 1705 Sir Isaac Newton replaced the sulfur globe with one of glass, and about 1733 Boze, a German, added metallic conductors, which became an essential feature of all later machines. A few years later leather rubbing pads were substituted for the hand, thus enabling the operator to dispense with an assistant whose duty it was to place both hands upon the rotating globe or cylinder. Finally, glass discs were substituted for the globe or cylinder, and all of these advancements finally culminated in what was probably the most powerful and largest frictional static electricity generating machine until modern times. This large machine, which was built by Dr Martin Van Marum, a Dutch scientist in 1785, contained glass discs over 5 feet in diameter which were turned by four men. A single spark from this machine would melt gold leaf and the attraction of a linen thread could be observed 38 feet away *(8)*.

Now, the availability of the static generators led to a host of electrical experiments of considerable importance. But many of the workers of this period in the electrical field were even more interested in the entertainment value and in some cases in the medicinal value of the electric force. Many of these workers were not adverse to making use of the static generator to give their friends the 'hot seat' and even John Wesley, the founder of Methodism, recommended the electric treatments as a cure for hundreds of diseases and ailments. *(9)*.

THE ELECTRIC FORCE IS STORED —THE LEYDEN JAR

Progress in electricity during the early part of the 18th century continued to be made. This progress was made by a small group of men living in Europe and even in America. Each of these men was as diverse in nature and in position as it is possible to conceive. In those days science was not the day to day business of professional scientists as we know it today, but the hobby or avocation of physicians, ministers, librarians and sometimes even merchants. Among those who made important discoveries in electricity during this early part of the 18th century, two names are particularly known to us: Dufay, who revolutionized the dyeing industry of France with his light fastness and wash fastness, and Benjamin Franklin—"the first civilized American."

During this period Dufay discovered that there were two kinds of electricity, which he called the vitreous and resinous. At almost the same time Franklin and his friend, Kinnersley, working in the comparative wilderness of America, invented their plus and minus electricity. The plus, or positive electricity of Franklin was the same as the vitreous electricity of Dufay, the minus or negative electricity being the resinous electricity of Dufay *(10)*.

During this period there was put forward a clear conception that some materials were conductors and some nonconductors, and the concept of electrical insulation also appeared. The idea that electricity was normally and uniformally present everywhere and in a state of equilibrium was put forward and generally accepted. In addition to these fundamental ideas and observations, many other observations of lesser importance were made, and many wild theories came forth to be discussed, argued about and then forgotten.

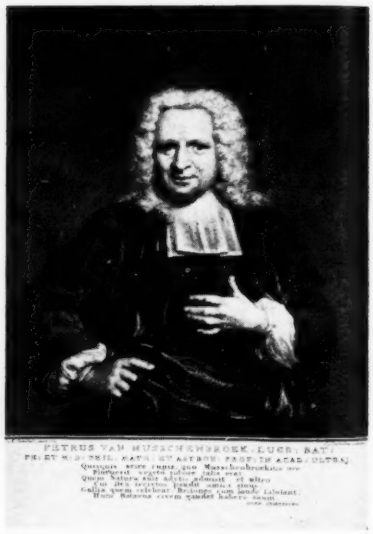


Figure 5
Contemporary engraving of Van Musschenbroek

Now, as we have mentioned above, the invention of the static-electricity generating machine has served to give a real push to the study of electricity, and, as we have seen, important observations and discoveries in electricity resulted. But each of these new discoveries were more or less isolated and one did not serve to bring forth the other.

In the middle of the 18th century a new invention was needed for a revival of interest in electrical science. A means had been at hand for producing the electrical force at will for almost a century. A means for storing this force after it was produced was needed. The invention of the Leyden jar was the answer. This single instrument was responsible for a great revival of interest in the study of electricity, and for 50 years after its invention important discoveries and observations poured forth in electricity, which could not have been made without this instrument.

We shall probably never know who first invented the Leyden jar. Its discovery has been credited to Bishop Von Kleist, dean of the Cathedral of Comin, in Pomerania, and to the celebrated Professor Van Musschenbroek of the University of Leyden. This invention was probably made independently by both, and sometime about the year 1745 *(11)*.

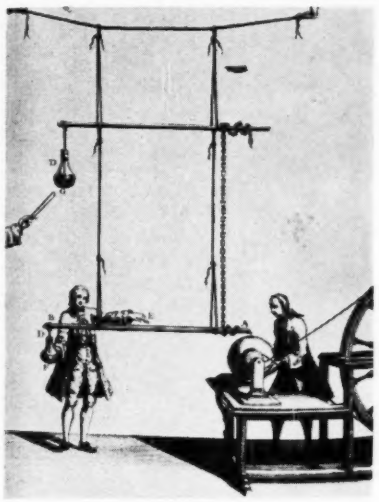


Figure 6
Eighteenth century engraving showing earliest experiment in charging Leyden jar from a frictional static generator

In its original form the Leyden jar was simply a glass bottle containing water. The water was connected to the electric generator by means of a metal wire, and the operator held the bottle in his hand. The jar could accumulate a very strong charge, which became apparent by touching the wire leading to the water.

Writing in 1746 to a friend, Musschenbroek describes the historic shock he received from the jar in the following words, "Suddenly, I received in my right hand a shock of such violence that my whole body was shaken as by a lightning stroke. The vessel, although of glass, was not fractured nor was the hand displaced by the commotion, but the arms and body were affected in a manner more terrible than I can well express. In a word, I thought I was done for" *(12)*.

While the Leyden jar served as the key instrument in many investigations, it itself was studied in detail and improved upon by many workers. In fact, it was the Father of the modern electrical condenser.

With the aid of the Leyden jar the idea of the closed electrical circuit became established, an idea of the almost instantaneous speed of electrical force became realized, and the knowledge that the earth as well as water could be used as a part of an electrical circuit became known.

Because of the great electrical force which could be accumulated in the Leyden jar, its use in spectacular experiments caused a widespread interest in electricity among people in general. One of the most striking experiments of this type was that performed by the famous Abbe Nollet with the co-operation of the whole community from the great convent of the Carthusians in Paris. A Leyden jar was was discharged through a circuit over a mile long. This circuit consisted of hundreds of monks alternating with short lengths of iron wire from person to person. We are told that, "upon a discharge of the Leyden jar the whole company of monks gave a sudden spring at the same instant, and all felt the shock equally" *(13)*.

The Leyden jar also served in many thousands of important but less spectacular experiments. Perhaps none were more important than those great experiments of Benjamin Franklin on lightning. This work of Franklin is so important to the history of static electricity and so wrongly known, that it bears retelling.

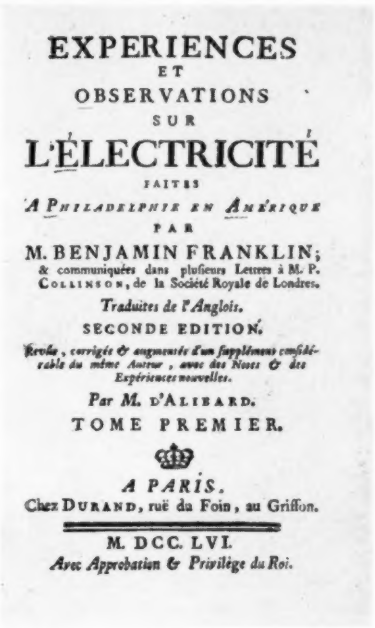
FRANKLIN AND THE LIGHTNING CONTROVERSY

Before it had been shown that lightning is a discharge of electricity similar to that obtained from frictional electric machines and Leyden jars, the terrifying effects of thunder storms were supposed to result, in the words of an early writer, "from explosions caused by the spontaneous ignition of sundry exhalations which had the habit of accumulating in the upper atmosphere." Before this the terrifying thunder and lightning were simply attributed to either the anger of God or to the work of the devil, the choice depending on whether one's friend or enemy had been struck by lightning at the particular time.

It is undoubtedly true that before Franklin several physicists had hinted at the similarity between electricity and lightning, but they did not pursue the subject. It is also true that Franklin was not the first to draw electricity from the clouds and prove experimentally that the "electric force" thus obtained was the same as that produced by rubbing a piece of amber. It is true that Franklin suggested the manner in which these experiments might be carried out, and he independently of others carried out the most satisfactory set of experiments and formed the clearest conclusions. Here is the story of the lightning "controversy" as we know the facts today.

Now, Franklin was the first to observe the properties and effects of pointed bodies both in drawing and throwing off static electricity. This knowledge was fundamental to the planning of experiments for drawing down electricity from the clouds. Also, in Franklin's diary, with the date of November 7, 1749, there are notes suggesting many reasons why lightning may be the same as the electric force.

In a letter to Collinson in London, written a bit later, these reasons are clearly stated and suitable experiments for proving his theory are suggested.



EXPERIENCES
ET
OBSERVATIONS
SUR
L'ÉLECTRICITÉ
FAITES
A Philadelphie en Amérique
PAR
M. BENJAMIN FRANKLIN;
& communiquées dans plusieurs Lettres à M. P. Collinson, de la Société Royale de Londres.
Traduites de l'Anglois.
SECONDE EDITION,
Revûe, corrigée & augmentée d'un supplément considérable du même Auteur, avec des Notes & des Expériences nouvelles.
Par M. d'Alibard.
TOME PREMIER.
A PARIS.
Chez Durand, rue du Foin, au Griffon.
M. DCC. LVI.
Avec Approbation & Privilège du Roi.

Figure 7
Title page of rare French edition of Benjamin Franklin's experiments on electricity

In France, the scientists Buffon, D'Alibard and DeLor were keenly interested in Franklin's work and planned to make experiments in accordance with Franklin's suggestions *(14)*.

At Marly in France D'Alibard, following Franklin's suggestions, erected a pointed rod 40 feet long and one inch in diameter and insulated from the ground. On May 10, 1752, during a heavy thunderstorm, sparks were drawn from this rod and one week later DeLor drew sparks from an insulated pole 99 feet high, which he had erected in Paris at the request of Buffon.

Franklin, at about the same time, was erecting an insulated rod in Philadelphia completely without knowledge of the Frenchmen's experiments. Before he was ready, he conceived the idea of sending up a kite which could easily reach heights many times greater than could be obtained with a rod. Franklin's first successful experiment with the kite was accomplished in June, 1752. Franklin's friend, Joseph Priestley, writing a few years later, gives the following account of the experiment.

"The kite being raised, a considerable time elapsed before there was any appearance of it being electrified. One very promising cloud had passed over it without any effect when, at length just as he (Franklin) was beginning to despair of his contrivance, he observed some loose

Figure 8
Charles A Coulomb

threads of the hempen string to stand erect, and to avoid one another, just as if they had been suspended on a common conductor. Struck with this promising appearance, he immediately presented his knuckle to the key," Priestley interpolates here, "let the reader judge of the exquisite pleasure he must have felt at this moment, the discovery was complete. He perceived a very evident electric spark. Others succeeded even before the string was wet, so as to put the matter past all dispute, and when the rain had wet the string he collected electric fire copiously." Franklin, of course, continued his studies in detail, performing many experiments by drawing down lightning with kites and with pointed rods and charging the Leyden jar many times *(15), (16).*

Now, some of us may say, "so what." Did the mere proof that lightning was the same as electricity serve any useful purpose? Was electrical science greatly advanced by this discovery? To this we must say, "yes." For not only did this knowledge contribute toward the intellectual development of mankind and remove some of the cobwebs of superstition from the minds of men, but it resulted in the practical protection of life and property from destruction by lightning, and to the advancement of electricity in general and static electricity in particular.

As textile chemists, we may well conjecture how very different Franklin's results would have been if his kite string had consisted of one of the low conducting fibers such as nylon instead of silk and hemp.

THE SCIENCE OF STATIC ELECTRICITY BECOMES OF AGE

A science is generally considered to have reached maturity when its conceptions can be expressed in mathematical terms. The science of electrostatics, or static electricity, thus became of age with the work of 2 men working independently, Cavendish and Coulomb, two men as different in personality, training, and private life, as can be conceived, yet in their method of approach to science, "identical twins." The question they asked was not simply, "how" or "why," but "how much."

Henry Cavendish was one of the leading English scientists of the 18th century. He was eccentric, afraid of people, and particularly women, but he contributed greatly to the progress of physics and chemistry. Although one of the richest men in all Europe, he cared nothing for the things that money could buy, and only the study of science afforded him any pleasure. He lived the life of a hermit and only shyly ventured forth in later years to spend an occasional evening in the company of other scientists.

Cavendish was methodical to a superlative degree, and this characteristic appears in his work and scientific publications. Even in his private life the same desire for accuracy and method existed. Possessing a large and fine scientific library, which he alone used, nevertheless, upon taking a book from the library shelves, he would charge himself with it and would carefully credit the entry when the book was returned to its proper shelf.

Cavendish's work in chemistry on the composition of water and the properties of hydrogen are well known. Besides this, he determined the average density of the earth and gave the first proof and quantitative measurements of the force of gravity.

In the field of electricity, Cavendish was far ahead of his times, for he made measurements on the electrical resistance of materials with astonishing accuracy and with equipment that we today would consider useless. Using the only means available to him at that time for measuring current, the electrical shock given to his own body, he was was able to state in 1776 that, "iron wire conducts about 400,000,000 times better than rainwater," and that "sea water or a solution of one part salt in 30 of water conducts 100 times," and "a saturated solution of sea salt, about 720 times better than rainwater." These figures are astonishingly close to those we have today, made with the most refined and complicated apparatus.

Besides his work on conductivity, Cavendish made many exact studies on the electrical capacities of condensers and surfaces. He was probably the first to have a clear idea of what we call electrical potential, and which he called, "degree of electrification." Finally, Cavendish conducted a series of experiments which caused him to conclude that, "the electric attraction and repulsion is invariably as the square of the distance." This law of

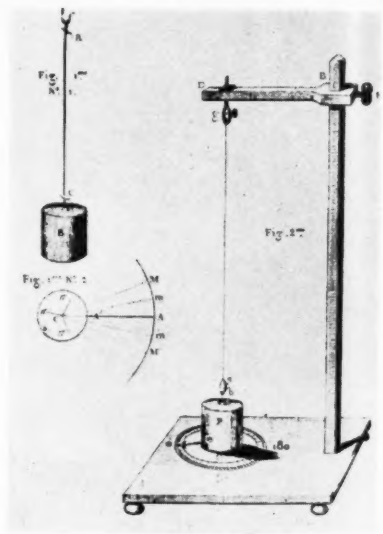


Figure 9
Engraving of apparatus used by Coulomb in proving the law of inverse squares

inverse squares however was given final and absolute proof by Coulomb *(17).*

In 1785 Coulomb completely proved to the world the law of inverse squares, for in that year he published the results of his experiments with his wonderfully sensitive torsion balance, with which he made direct measurements of the forces between electrified bodies.

Coulomb's torsion balance is much better known to every student of physics than his life. His balance was uncomplicated, carefully devised and astonishingly accurate. Its parts consisted of such ordinary things as a glass cylinder, silver wire, a thin straw covered with shellac, varnish paper and ordinary pithballs. With this instrument he made his measurements, which not only established the mathematical expression for electrical attraction and repulsion, but which defined the unit of electricity or electrical quantity, a unit which today is properly called the coulomb.

Coulomb's life was complicated, fill of contradictions and often unhappy. Coulomb, born in France in 1736, five years after Cavendish, also came from a family of high social standing. Coulomb was trained as a military engineer and spent a number of years in engineering work in France and on the island of Martinique. Unfortunately, Coulomb was not a politician, and his rigid scientific accuracy in his engineering reports did not always fit the desires of those who stood to gain financially by slight deviations from this accuracy. Because of this uncompromising honesty, Coulomb made enemies in high places who succeeded in upsetting his engineering career.

Coulomb was a great scientist, however, and in spite of ill health and many misfortunes, he was able to find solace in his work on electricity.

Coulomb, like Cavendish, studied the distribution of electricity over the surface of conducting bodies. He showed that "distribution of electricity over the surface of two bodies brought into contact, or merely within each other's influence, depends upon the shapes and dimensions of these bodies and not upon their material or mass." In this work he used a torsion balance so sensitive that a force equivalent to 1/60,000 of a grain could easily be measured.

Although Coulomb was a fine mathematician, he was not able to obtain a mathematical expression for the distribution of electricity on the surface of bodies. It remained for another French scientist, Poisson, to put the pioneer work of Coulomb into mathematical form five years after Coulomb's death. Nevertheless, the title, "Father of the science of electrostatics" is due more to Coulomb than to any other man *(18)*.

TEXTILE INDUSTRY REVIVES INTEREST IN STATIC ELECTRICITY

The dawn of the 19th century marks the beginning of the industrial revolution, and a new dynamic age in man's life and thought. The first year of the 19th century also marks the dynamic age in electricity, for on March 20th, 1800, Alexander Volta sends a letter containing the first description of his "electrical battery" to the President of the Royal Society *(19)*. The interest of the scientific world in static electricity almost immediately disappears and is transferred to electricity in motion, the power of which has so transformed our world. Almost 150 years is to pass before there is a revival of interest in the study of static electricity.

Today, the revival of interest in the science of static electricity is due mainly to the textile industry. The recent introduction of many new fibers which are strong static producers has posed problems for the manufacturer and consumer of these new textiles.

The solution of these problems can be made by the application of scientific principles described long ago, coupled with our modern knowledge, in many new fields. Many of these old principles are apparently being rediscovered by workers who have not realized that the ground was covered very thoroughly many years ago.

The study of static electricity in textile fibers and other plastic materials is not new. Only the reason for the study is new, for the old workers made their studies out of purely scientific consideration. Today, these studies are made for purely practical reasons.

STATIC IN TEXTILES STUDIED LONG AGO

Even in the early days of our own country, static and textiles went together like ham and eggs. A Mr Clayton, writing to Robert Boyle on June 23rd, 1684, from Jamestown in Virginia, gives an account of a strange accident, as he calls it, which happened to a Mrs Sewell, whose wearing apparel ballooned out and emitted a flashing of sparks which were seen by several persons, and, he reports, "the like happened to Lady Baltimore, her mother-in-law." *(20)*.

Today, in our study of static electricity in textiles, we are particularly concerned about how static develops on contact, the effect of pressure and friction and the effect of chemical agents in the development of this charge *(21)*.

In a set of papers presented before the Royal Society in 1759 by Symer, there is a more extensive report on many of these factors than has been published in any modern writing. Symer made his studies with silk stockings. He noted that static electricity only became evidenced on the separation of the textiles, that a charge could develop on simple contact, and that pressure and friction increased the amount of charge. He found that chemical treatment modified the static properties, and he actually measured the charge built up in textiles as well as the force existing between charged textiles under various conditions *(22)*.

In a paper on static electricity in textiles delivered just a few years ago, great emphasis was placed on an "electrostatic series," which the author had prepared by rubbing pairs of various substances together and determining which substance became positively charged and which negatively charged, and then arranging these substances in a series so that a substance higher in the series would always develop a positive charge when rubbed with any material lower in the series. Writing in 1769, Joseph Priestley describes the work of Wilkhe, who in 1758 made many experiments on rubbing various pairs of substances together and determining which substance developed a positive charge of electricity and which a negative charge. Priestley describes this work in the following words, "after these experiments, Wilkhe gives the following catalog of the principal substances with which electrical experiments are made, in the order in which they are disposed to acquire positive or negative electricity; any of the substances becoming positively electric when rubbed with any that follow it in the list, and negative when rubbed with any that proceed it," and Priestley gives Wilkhe's list as follows:

smooth glass	sealing wax
woolen cloth	white wax
quills	rough glass
wood	lead
paper	sulfur
	and other metals

All that Wilkhe would have needed to sound like a modern worker in the field would have been to include in his list the modern synthetic fibers *(23)*, *(24)*.

Many other examples of modern-sounding work from the past could be given. Even our modern instruments for measuring static in textiles are simply versions of Von Guericke's original "static generator," but I believe our point has been made.

The work of the past is not always obsolete. Everything that is new has its origins in the old. In all humility, let us accept and use the heritage we have received from all the workers in static electricity. With this as a foundation, we shall develop new ideas and new principles which shall cure the headache of static for the textile industry.

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1952 Annual Convention——

PRINCIPLES OF COPPER DYEING OF POLYACRYLONITRILE FIBERS: THE CONTROLLED REDOX-POTENTIAL METHOD*

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Contribution No. 133 from Jackson Laboratory
E I du Pont de Nemours & Co, Inc, Wilmington, Del

R H Blaker

A brief review is given of the copper method for dyeing polyacrylonitrile fibers. The theory of the process is presented and a description is given of the influence which the important variables of temperature, pH of the dyebath, and concentration of cuprous ion have on the dyeing.

The application of redox potential measurements to copper dyeing is described in detail. It has been found empirically that satisfactory dyeings will be obtained if the redox potential of the dyebath is maintained within certain millivolt limits. The redox potential of a dyebath depends on several variables but is influenced chiefly by the amount of reducing agent present in the bath. It is, therefore, possible to use redox potential measurements to regulate the addition of reducing agent to a dyebath in such a manner as to insure satisfactory dyeing. The utility of redox potential measurements is illustrated by the description of dyeing procedures based on their use.

INTRODUCTION

THE copper dyeing method, which was first described for the dyeing of dynel, has been successfully applied to the dyeing of "Orlon"† acrylic fiber (*1,2*). This process has made possible the dyeing of a full shade range on "Orlon" in equipment where the maximum dyeing temperature is 212°F. The process is also applicable at higher temperatures in pressurized equipment, in which "Orlon" can be dyed rapidly to have excellent fastness properties.

The theory of the copper dyeing procedure *(2)* is relatively simple, but the practical application of the method requires careful control. This paper consists of a review of the principles of copper dyeing in the light of considerable mill experience and of a description of the use of redox-potential measurements to control the most critical feature of the method, the addition of reducing agent to the dyebath.

PRINCIPLES OF COPPER METHOD

The copper method is unique among dyeing procedures in that the addition of cuprous ions to a dyebath creates in "Orlon" an affinity for acid dyes, a class of dyes which ordinarily cannot be applied to this fiber. The method appears to be limited to polyacrylonitrile fibers and to the application of acid and selected direct dyes on these fibers.

The method consists in adding copper sulfate and a reducing agent to a bath containing the fiber and an acid dye and maintaining the bath at or very near the boil. The copper sulfate and the reducing agent react in the bath to produce copper in the cuprous valance state. The cuprous copper is then absorbed by the "Orlon" acrylic fiber and in so doing creates an affinity for acid dyes.

A simplified picture of copper dyeing is presented in Figure 1. This figure shows one cuprous ion, one dye molecule, and a fragment of "Orlon" in a dyebath. The presence of the "Orlon" is represented by the familiar "dog-bone" cross section. This figure is intended to show that, while the dye molecule by itself has no affinity for "Orlon", the cuprous ion does have affinity. In the dyeing process, the cuprous ion is rapidly absorbed by the fiber and then, and only then, does the dye molecule enter the fiber.

The attractive force that draws the cuprous ion into the "Orlon" is undoubtedly the capacity of the cuprous ions to form complexes with the nitrile groups of the polyacrylonitrile. The exact nature of the complex is not known, but a few of the possible arrangements of cuprous ions with the nitrile groups of a polyacrylonitrile molecule are shown in Figure 2. A cuprous ion may form a complex with a single nitrile group. It may combine with two nitrile groups from adjacent molecules of polyacrylonitrile and thus crosslink the two molecules. It may form a complex with a nitrile group near the end of the molecule, and, finally, it may combine with two adjacent nitrile groups on a single molecule. In all cases, however, once the cuprous ion has been absorbed, it has the capacity to attract a dye molecule into the fiber.

A practical dyeing procedure for "Orlon" acrylic fiber has been developed by use of these reactions of cuprous copper and dye with polyacrylonitrile. The development of this procedure has been guided by five principles:

1) The copper must be in the cuprous valence state to be effective in promoting the dyeability of acrylic fibers.

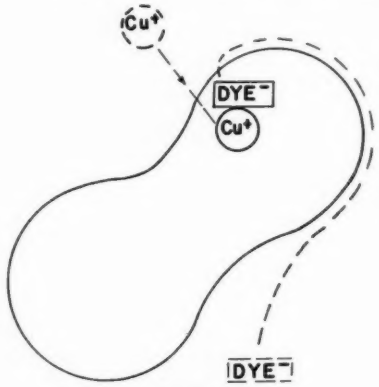

Figure 1
A Cross-Section of "Orlon" Acrylic Fiber Being Dyed

* Presented at the Hotel Statler, Boston, Mass, on Nov 7, 1952.
† "Orlon" is the trade-mark for acrylic fibers manufactured by Du Pont.

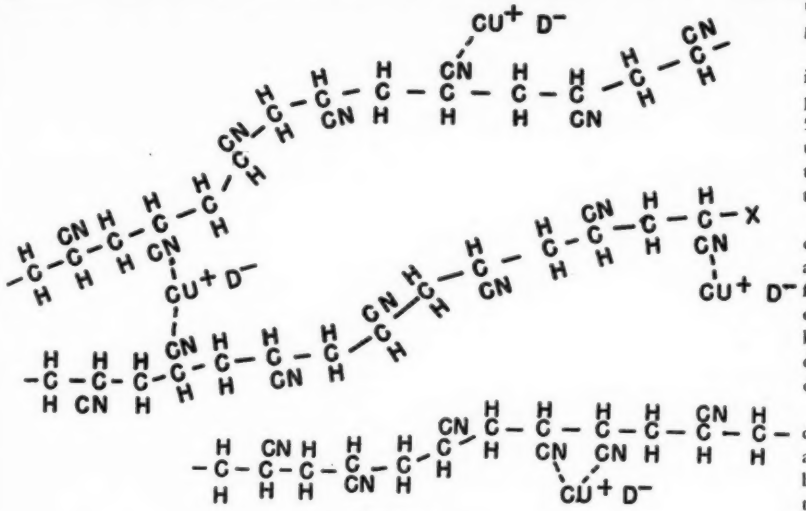

Figure 2
Sites for Copper Absorption

2) The amount of dye absorbed is proportional to the amount of cuprous copper absorbed by the fiber.
3) The amount of cuprous copper absorbed by the fiber is proportional to the concentration of cuprous copper in the dyebath.
4) The amount of cuprous copper absorbed depends on the pH of the dyebath.
5) The rate of copper absorption depends on the temperature and is very slow below 212°F.

The success of copper dyeing depends on the presence of the correct amount of cuprous copper in the dyebath. In principle, the copper could be added to the dyebath in the form of a cuprous salt; in practice it has been found necessary to produce the cuprous copper directly in the dyebath through the reaction of a cupric salt, usually copper sulfate, and a suitable reducing agent.

The amount of copper absorbed by "Orlon" acrylic fiber depends on the concentration of cuprous ion in the dyebath, that is, not alone on the total amount of copper added to the bath, but also on the ratio of copper to the volume of the dyebath. The effect of bath-to-fiber ratio on amount of copper absorbed is shown in Figure 3.

The pH of the dyebath has a marked influence on the amount of cuprous copper and hence on the amount of dye which can be absorbed by the fiber. This effect is shown by Figure 4.

These data indicate that the absorption of copper decreases if the pH of the dyebath is below the range of 2.0 to 3.0. At higher pH values more copper is absorbed, but the coppered "Orlon" has a tendency to become yellow if the pH of the bath is greater than about 3.0.

The rate of absorption both of cuprous ion and dye depends strongly on the temperature of the dyebath as shown in Figure 5. These data indicate that for maximum utilization of both copper and dye, the temperature of the dyebath must be maintained near 212°F.

The data which have been presented indicate that only part of the copper that is added to the dyebath is absorbed by the fiber. It is also true that only part of the copper which is absorbed is effective in binding dye to the fiber. The approximate distribution of copper and dye between the dyebath and "Orlon" is shown in Figure 6.

"Orlon" acrylic fiber is not difficult to dye by the copper method if proper allowance is made for the five factors that have been discussed. The production and maintenance of the proper amount of cuprous copper in the dyebath is the most critical feature of the method, but this problem is simplified by the process which will now be described.

Early in the development of the copper dyeing process, it was shown that in most cases the dyer should add only that amount of reducing agent to the dyebath which was required to reduce the cupric salt to the cuprous state. Any excess of the reducing agents then known would further reduce the cuprous ion to metallic copper and a larger excess would begin to destroy the dye. The dyeing procedure was further complicated by the fact that both the cuprous ion and the reducing agents are readily oxidized through contact with air. Hence, aeration of the dyebath had to be minimized and reducing agent lost in this way had to be replaced if the dyeing was to be satisfactory.

REDOX CONTROL OF REDUCTION

Recently we have developed a process for controlling the reduction of the copper sulfate in which a variety of reducing agents

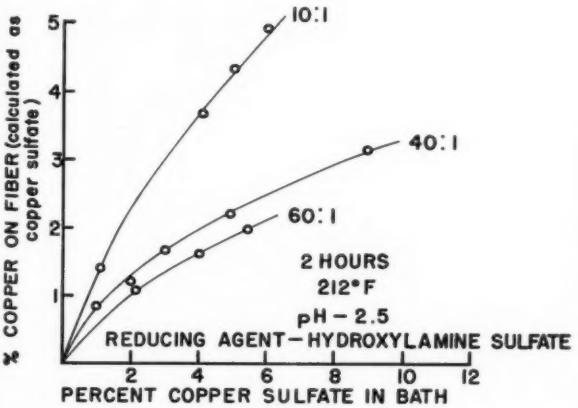

Figure 3
Effect of Volume Ratio on Copper Absorption

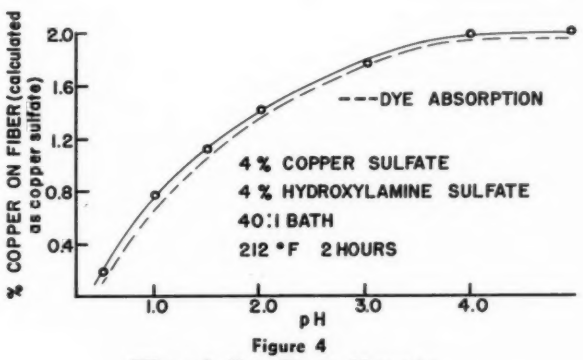

Figure 4
Effect of pH on Copper Absorption

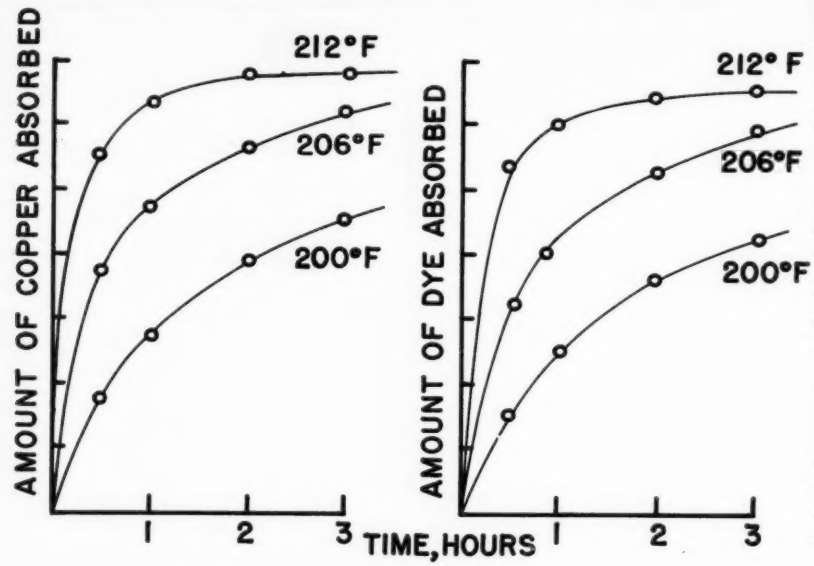

Figure 5
Rate of Absorption of Copper and Dye

may be used. This process, based on simple redox-potential measurements, makes it possible for the dyer to avoid the difficulties caused by insufficient or excessive amounts of reducing agent.

It is well known that an electrical potential is generated between certain electrodes when they are immersed in a solution that contains either an oxidizing or a reducing agent. This voltage, which is proportional to the redox potential of the solution, can be an indication of the capacity of the solution for undergoing a reaction either of oxidation or reduction. The voltage is very small but can easily be measured without polarization of the electrodes by commercially available instruments that have adequate input impedance.

The process which we have developed consists of two parts: first, the reduction potential of the dyebath is measured to learn whether or not sufficient reducing agent is present to reduce the cupric copper and, second, reducing agent is added to the dyebath at such a rate as to maintain that value of redox potential which indicates that the cupric copper has been reduced. The principle of this process is illustrated by Figure 7.

This figure shows the change in the apparent redox potential as a reducing agent is added to a bath containing dye and copper sulfate. If too much reducing agent is added, there is danger of formation of metallic copper and destruction of dye. If insufficient reducing agent is added, little or no cuprous copper will be formed and no dyeing will take place. There is, however, a wide range of redox potential in which satisfactory dyeings can be made.

The instruments that have been used for making redox potential measurements in large-scale equipment are shown in Figure 8. The measurements are made with a pH meter equiped with a millivolt scale. One of the electrodes is a conventional calomel electrode and the other is a high-temperature platinum electrode. For the range of redox potentials useful in reducing cupric copper to the cuprous state, the calomel electrode is connected to the positive terminal of the potential measuring instrument. With this connection the readings become smaller for increasing reductive intensity; this is opposite to the situation with alkaline hydrosulfite in vat dyeing, for which the connections are reversed from those employed here. This reversal of electrode connections is made by means of a selector switch on the instrument rather than by any change in the external connections. The electrodes shown in the photograph are protected by an industrial-type electrode holder. The recorder which is shown is not necessary but is convenient since it provides a continuous record of the state of reduction of the dyebath.

The reduction potential of a dyebath has been found to depend somewhat on the temperature and pH of the bath and the concentration of salts. This has made it difficult to calculate the optimum millivolt value or range of values for dyeing; instead, these values have been based on experimental results.

It has been found that, if hydroxylamine sulfate is used as the reducing agent for dyeing at or near the boil in a pH range of 2.5 to 3.5, satisfactory dyeings will result if the redox potential of the bath is maintained between 40 and 120 millivolts. The rate of dyeing will be greater if the millivolt value is maintained near the lower limit; the rate is much less at 120 millivolts and is still less at higher values.

The control of a copper dyeing of "Orlon" acrylic fiber by the aid of millivolt readings on the dyebath is illustrated by Figure 9. This figure is a recorder tracing showing the changes in the millivolt reading of a dyebath during an actual dyeing of "Orlon" acrylic fiber. The dye was added to the bath at 140°F, and the copper sulfate,

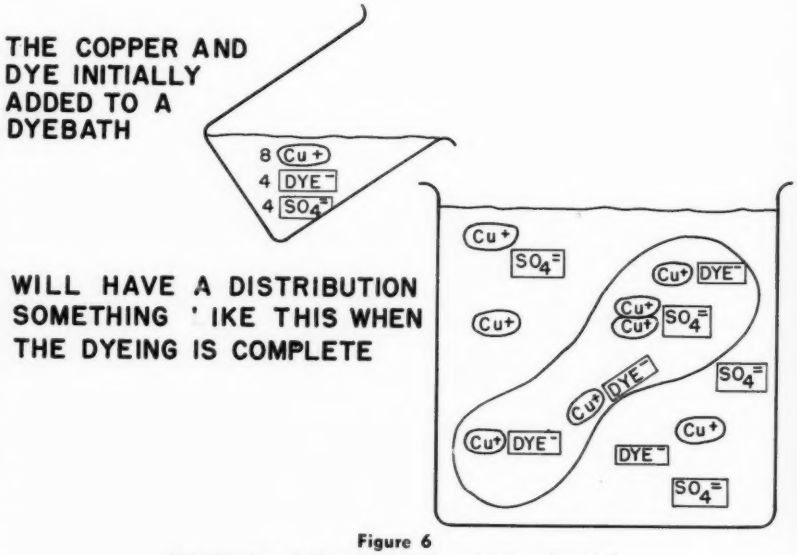

Figure 6
Distribution of Copper and Dye between Dyebath and "Orlon" Acrylic Fiber

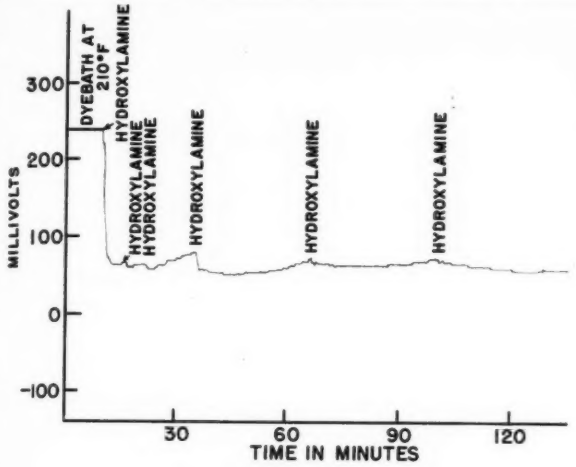

Figure 9
Redox-Potential Control of a Beck Dyeing

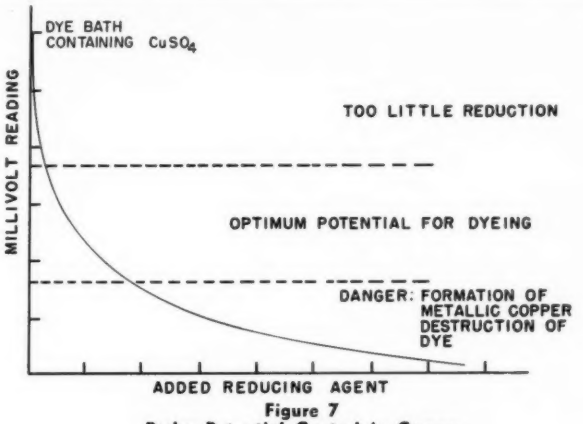
DYE BATH CONTAINING $CuSO_4$
TOO LITTLE REDUCTION
OPTIMUM POTENTIAL FOR DYEING
DANGER: FORMATION OF METALLIC COPPER DESTRUCTION OF DYE
MILLIVOLT READING
ADDED REDUCING AGENT

Figure 7
Redox-Potential Control in Copper Dyeing of "Orlon" Acrylic Fiber

at 180°F. The bath was then heated to 210°F, and a recorder was connected to the pH meter. The dyebath gave a reading of 230 millivolts at this temperature with only the dye and copper sulfate in the bath. It was decided to maintain the millivolt reading of the bath between 60 and 70 during the dyeing. A dilute solution of hydroxylamine sulfate was added to the bath at intervals as shown by Figure 9. The millivolt reading dropped to the desired value with the first addition of the reducing agent. Each time the millivolt reading began to rise, it was brought down by an addition of hydroxylamine. A total of five additions were required over the two-hour dyeing period to keep the millivolt value within the desired range. The dyeing was satisfactory.

The same general procedure would have been used if sodium or zinc formaldehyde sulfoxylate or sodium bisulfite had been used as the reducing agent.

This procedure, which we call the controlled-redox-potential method, is very useful when dyeings are made in new equipment or when new formulas are being established. A schedule, based on redox-potential measurements, can be devised for adding reducing agent under a given set of conditions. Once this has been done, further millivolt readings are usually unnecessary and a satisfactory redox potential can be maintained by using the same rate of addition of reducing agent.

Figure 8
Redox-Potential Control Equipment

EXPERIMENTAL MACHINE RUNS

Redox-potential measurements have been used to guide the copper dyeing of "Orlon" acrylic fiber in numerous types of dyeing equipment. The following examples will illustrate the method.

A rust shade was to be dyed on 100 lb of type-41 "Orlon" rawstock in a Morton machine. The stock was scoured at 160°F for 15 minutes at a bath-volume ratio of 17:1. The scouring bath was dropped, the machine was refilled, and the bath was heated to 120°F. Three percent copper sulfate crystals was added, the bath heated to 160°F and the dye added. The dye formula was 1.55% DuPont Orange RO, 0.17% DuPont Anthraquinone Blue SWF Conc 150%, and 0.24% DuPont Quinoline Yellow PN. The bath was then heated to 180°F. The millivolt reading on the bath at this temperature was 330. Approximately one half gallon of a dilute solution of hydroxylamine sulfate (2 lb in 5 gallons) was then added to the expansion tank of the machine; the millivolt reading was reduced by this addition to 100 millivolts. The temperature of the bath was increased during 20 minutes to 208°F, and the millivolt reading lowered to 80 by the addition of more of the hydroxylamine sulfate solution. These temperature and millivolt readings were maintained for 1 hour, and the dyebath was then well exhausted. About 1.5 gallons of the hydroxylamine sulfate solution was used (0.7 lb) during the dyeing. The stock was scoured for 10 minutes at 160°F with 0.5 lb "Duponol" D paste. A good dyeing was obtained by this method, and a 40% saving was made in the amount of hydroxylamine sulfate usually required for this formula.

Redox-potential measurements were also

used to develop a dyeing procedure for "Orlon" acrylic fiber in a pressurized hosiery machine. The problem was to dye a light yellow shade on hand knitting yarn by the copper method.

Five pounds of yarn in bags was placed in the machine containing 50 gallons of water giving a bath-to-fiber ratio of about 80:1. The temperature was brought to 140°F. Two percent copper sulfate, 0.125% DuPont Quinoline Yellow PN, and 0.5% sodium nitrate owf were added to the bath, and the pH was adjusted to 2.8 with sulfuric acid. The temperature was increased to 205°F, and 0.5% sodium bisulfite was added. The millivolt reading was 170 at this temperature. The machine was pressurized and the temperature was increased to 220°F. After 20 minutes at 220°F, a sample of the dyebath was removed and a reading of 160 millivolts was obtained. The dyeing was continued for 35 minutes at 220°F to see if any dyeing would take place even though the redox potential of the bath was outside the proper range. When the machine was finally opened, it was found that only a very small amount of dye had gone on the fiber, as was predicted from the redox measurements.

A second run was made by the same procedure, but, instead of 0.5% sodium bisulfite at 205°F, a dilute solution of sodium bisulfite was added until the redox potential of the bath was decreased to 70 millivolts. The machine was then pressurized and a satisfactory dyeing was obtained.

Redox potential measurements have proved useful in the dyeing of piece goods. The problem was to dye a green shade on a fabric composed of type-41 "Orlon" acrylic fiber. A small beck was used. The fabric was scoured at 160°F, rinsed, and a 40:1 bath made up. Four percent copper sulfate was added at 120°F and the dye at 160°F. The dye formula consisted of 1.5% DuPont Anthraquinone Blue SWF Conc 150% and 1.1% DuPont Quinoline Yellow PN. The bath was heated to 210°F, and a dilute solution of hydroxylamine sulfate (2% solution) was added to the bath to reduce the millivolt reading to 50. The potential dropped slowly as the hydroxylamine sulfate solution was added, probably because of the slow rate of mixing of the solution with the dyebath. The potential was maintained between 50 and 60 millivolts for two hours by the addition of hydroxylamine sulfate each time the potential rose above 70. A satisfactory dyeing was obtained with a 50% saving in the amount of hydroxylamine usually used for this shade. It was interesting to note an immediate rise in the millivolt reading each time the door of the beck was opened indicating loss of hydroxylamine sulfate by reaction with air.

SUMMARY

A description has been given of the principles of copper dyeing of polyacrylonitrile fibers and of "Orlon" acrylic fiber in particular. Experience has shown that, if satisfactory dyeings are to be obtained, the copper added to the dyebath must be reduced to the cuprous form and maintained in the cuprous state during the dyeing, the temperature of the dyebath must be close to the boil, and the pH of the dyebath should be between 2 and 3.

We have found that redox-potential measurements on the dyebath are a convenient way of determining whether or not the copper is in the cuprous state. With a reasonable amount of care, redox potential measurements can be used as a guide for the addition of reducing agent to large-scale dyeings to insure proper reduction of the copper sulfate and hence successful dyeings. This procedure, the controlled redox-potential method, has been successfully demonstrated in a variety of dyeing equipment.

ACKNOWLEDGMENTS

Grateful acknowledgment is made of many helpful discussions with J F Laucius and R A Clarke of this laboratory.

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1953 NATIONAL CONVENTION

CONRAD HILTON HOTEL, CHICAGO, ILL.

SEPTEMBER 17-18-19

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BOOK REVIEW

FORADLAD TEXTIL (FINISHED TEXTILES)

AB Alf Stigens Fabriker, Sandered, Sweden

(1952)

(Note: The following review is reprinted in English from the Swedish journal *Sve·ige-Nytt.* Further information may be obtained from the Swedish-International Press Bureau, Brunkebergstorg 14, Stockholm, Sweden.)

One of the most complete popular works on the art of dyeing and finishing textiles ever written in Sweden has been published by one of the country's leading dye works, AB Alf Stigens Fabriker, in celebration of their 20th anniversary. Carrying the title "Förädlad textil" (Finished Textiles) this work of nearly 200 pages also gives an interesting account of the history and development of the dyeing trade ever since it was inaugurated by Asian civilizations some time in the dim past. It relates the fascinating story of indigo and purple and other dyes known thousands of years ago. Striking evidence is produced that few things have played a greater part in man's imagination than color. When dyeing was first introduced into Sandinavia cannot be definitely asserted but most likely it was in pre-Christian time. The development of the dyeing trade in Sweden through the centuries—from a skilled craft into a modern industry utilizing the latest achievements of science—forms another interesting chapter in the work published.

The production of colors is older than that of textiles, it is pointed out in the introductory chapter. The cave paintings in Dordogne, France, estimated to have an age of 20,000 years, show naturalistic animal pictures in red, black, brown and yellow. The color stuffs used for these paintings have been mixed with marrow fat and urine.

When it comes to determining the origin of the art of dyeing textiles in the oldest known high civilizations in Asia and North Africa, the order of sequence seems to have been China, India, Egypt. Our knowledge is, however, very vague, and it might be that the Chinese first learned from India, which, at any rate, is the home of the indigo. Finds of shroud tape from mummies indicate that the old Egyptians already knew how to tint textiles about 3,000 BC. The Phoenicians are regarded as having introduced dyeing with purple, the most expensive and beautiful color substance known to antiquity. It was produced from crushed purple mollusks, and the great purple extract industries in the vicinity of Tyre and Sidon consumed annually millions of such mollusks. As every one of them gave just a few drops of dyestuff the method was very costly. Purple-tinted cloth was therefore originally reserved only for emperors and kings. The Persians were also skilled dyers, and Plutarch relates how Alexander, when conquering the town of Susan, found 5,000 talents of purple cloth which had been stored there for 190 years without losing its original fresh color.

The Greeks learned to use further types of dyestuffs, launching such classifications as olive green, myrtle green, sea green and sky blue. Moreover, they learned to dye linen. The inhabitants of ancient Sparta had their special view on the trade: To tint was to betray nature. Therefore, the first dyers were ordered out of the town because "they deprived the wool of its whiteness".

The Romans were also masters of the art. Dyehouses and well-preserved wall paintings excavated at Pompeii have contributed greatly towards throwing light on the dyeing industry of the time. Purple-dyeing was the most distinguished branch of the trade, but the Romans also developed great skill in using other colors.

During the epoch of the German migrations the Roman dyeing industry was practically destroyed, but fortunately the art survived in Byzantium and in the Near East. Benefiting from the contacts established through the Crusades at the end of the 10th century AD the art of dyeing began once more to flourish in Europe. Venice, Florence, Genoa and Milan soon became leading centers in this field. In Venice and also in Florence dyeing was given the dignity of fine art.

Gradually the textile and dyeing industry spread over Europe, centers like Bruges, Ghent, Malines and Ypres early offering competition to the Italian cities. The new Swedish book, which is profusely illustrated with interesting old drawings and woodcuts as well as with modern photographs—many of them in color—goes on to describe the development through the centuries in Switzerland, Portugal, Spain, England, Germany, France and other countries. It deals with the introduction of new methods and new textiles, such as silk, and it also records the use of previously unknown dyestuffs as the Mexican cochineal, which was brought to Europe after Columbus' discovery of the New World.

The book also records antique as well as later historical literature in the field of dyeing and tinting; moreover, the authors give an interesting rendering of the regulations governing the trade in various countries. In France, for instance, a law was issued in 1669, Ars tinctoria fundamentalis, with detailed regulations as to what colors the different dyers were allowed to use. They were divided into three groups, fine dyers, common dyers and silk dyers, and only the first-mentioned were allowed to use such fine dyes as indigo, woad, madder, cochineal and kermes. Among the wealth of interesting and amusing details it may be mentioned that at the end of the 18th century the dyers of London received the unique privilege of keeping swans on the Thames, a right otherwise reserved for the King.

It is but lately that Sweden has become more widely known as a textile country. Today she not only covers a large part of her own demand but is also in a position to export certain specialties. As a rule the mills, even the small ones, are of a high standard. Intensive research is being carried on in public and private textile laboratories, and there are several special schools for the training of experts, including a professorial chair in textile chemistry in Gothenburg.

The textile trade is, however, by no means new in Sweden, though it is only during the last decades that it has developed into a large-scale industry. When the Swedes first learned the art of dyeing cannot, as stated, be definitely ascertained. Ever since the 11th and 12th centuries there are records of the trade. The well-known Swedish historian Olaus Magni states in his famous history "De gentibus septentrionalibus", published in Rome in 1555, that "in the warmer spots of the North where flax is cultivated threads are spun which are woven and dyed so skilfully that one is apt to believe that the work was done in Latium".

The Vasa Kings reigning during the 16th and 17th centuries did much to promote the textile and dyeing trade in order to cover the demand of the armed forces and to avoid expensive imports. Several weaving mills were established, and in 1649 the first silk mill was started. At the beginning of the 18th century the private dyers and the Government intensified their collaboration. A special dyeing director was appointed by the Board of Trade, who had at his disposal a test dyeing plant. He also received most valuable assistance from the famous Swedish nat-

uralist Carl Linnaeus and his pupils. Useful domestic dyeing herbs were discovered, among which the stone-rag (Lichen saxatilis) came to be of great importance. It was used for red dyeing under the name of Boras Colour, after the textile town of Boras. During the period 1780-1814 considerable quantities of stone-rag were exported to Holland, Scotland and other countries.

The Swedish dyehouses were as a rule small, only a few hands being employed. The number of such plants was, however, relatively large, statistics from 1790 revealing that there were 125 dyehouses in 67 towns. In the middle of the 19th century Norrköping was the leading dyeing town, its keenest competitor being the growing textile center of Boras. From that time on, the small handicraft dyehouses began to disappear, giving way to large mechanized plants. About half the number of hands now employed in the trade are engaged in special dyeing and finishing firms, while the rest are on the staffs of textile mills running their own dyeing departments.

Gradually, as the textile trade developed, keeping pace with modern technique, the work of the dyeing houses has been extended to include additional links in the manufacture, such as mercerizing, crease-, moth- and flame-proofing, etc, not forgetting printing according to novel methods. Thanks to the fact that Sweden has developed an extensive dyeing and finishing industry, it has been possible largely to confine the imports of textiles to semifinished products, the further processing being done in the country.

NEWS

• ECP to Handle Marketing of Eastman Chemical Products

James C White, President of Tennessee Eastman Company, has announced that the marketing of chemical products manufactured by the Tennessee Eastman and Texas Eastman divisions of Eastman Kodak Company hereafter will be handled by Eastman Chemical Products, Inc, Kingsport, Tennessee.

J C Stone, formerly Executive Vice President of Tennessee Eastman Company, has been named President of the new organization. Among other appointments were:

Plastics—S E Palmer, Vice President, and D C Williams, Sales Manager

Chemicals—H L Ford, Vice President and J E Magoffin, Sales Manager

Textiles and Advertising—R L Churchill, Vice President; A A Owen, Manager, Textile Sales Service; C F Earnhardt, Jr, Manager, Order and Planning Department; and R C Tuttle, Advertising Director.

Eastman Chemical Products, Inc, will act as sales representative for Eastman's Tenite plastics, Eastman industrial chemicals and dyestuffs, and will handle the advertising of all Tennessee Eastman and Texas Eastman products. A M Tenney Associates, Inc, will continue as sales representative for Eastman acetate yarn and staple. All other personnel heretofore engaged in sales, sales service, and advertising functions for Tennessee Eastman Company will serve in similar capacities for the new company.

It is stated that the new organization was formed to provide a more efficient mechanism for the marketing of not only Tennessee Eastman's products but also those of the growing Texas Eastman division. Offices of Eastman Chemical Products, Inc, are planned for the following cities: Kingsport, Tenn, New York, N Y, Lodi, N J, Providence, R I, Framingham, Mass, Leominster, Mass, Rochester, N Y, Cleveland, O, Dayton, O, Detroit, Mich, Chicago, Ill, St Louis, Mo, Houston, Texas, Greenville, S C, and Greensboro, N C. The Wilson & Geo Meyer & Company and Wilson Meyer Company will continue as sales representative on the West Coast with offices in Los Angeles, San Francisco, Portland and Seattle.

Changes in the organization at Tennessee Eastman Company included the election of the following officers:

J G McNally, Vice President and Director of Research

H D McNeeley, Vice President

R S Leonard, Assistant Vice President

Philip Farnham, Assistant Vice President

R L Flanary, Comptroller.

At Texas Eastman Company, H H Imray was elected Vice President and E F Sefrna, Assistant Secretary.

• Heyden and Monsanto to Build Methanol Plant at Texas City

Heyden Chemical Corporation and Monsanto Chemical Corporation have entered into an agreement to build a methanol plant adjoining Monsanto's new acetylene facilities in Texas City, Texas, it is learned.

The methanol plant will use by-product gas from the acetylene operation. Heyden and Monsanto will share equally in the cost of construction and in the output of the plant, which will have approximately 25 million gallons per year capacity, it is reported. Commercial production is scheduled to begin in January, 1955.

According to the terms of the agreement between Monsanto and Heyden, the joint enterprise will continue for a period of years and provides for optional termination thereafter.

• Training Course in Water Pollution Abatement

An advanced training course for sanitary engineers in water pollution abatement programs will be held March 2-13 at the Environmental Health Center, 1014 Broadway, Cincinnati 2, Ohio. Letters of application should reach the Chief, Specialized Sanitation Training Section, Environmental Health Center or the appropriate Public Service Regional Office as early as possible.

The agenda for the course will be published in the February 16th issue of ADR.

• TCMA Meeting

The Textile Chemical Manufacturers Association will meet Tuesday, February 17th, at Beck's on the Boulevard, Philadelphia, at 12 noon. The Executive Committee will confer at 11 a m prior to the luncheon session.

• Thomas Awarded 47th Perkin Medal

Any moratorium on scientific progress for a period as short as even fifty years would throw mankind back to an existence like that of the Dark Ages, said Charles Allen Thomas of St Louis in accepting the 47th impression of the Perkin Medal, highest award for achievement in American Industrial chemistry, at a dinner in his honor at the Waldorf Astoria Hotel, New York, on January 17th.

To show the importance of science and technology in modern life throughout the world, Dr Thomas answered the question, "What would happen with a 50-year world moratorium on science"?

Dr Thomas is president of Monsanto Chemical Company and chairman of the board of Directors of the American Chemical Society. He was honored for outstanding contributions to the chemical technology of automotive fuels, of catalysts, of synthesis of valuable products from petroleum, and of atomic energy.

The Perkin Medal, founded in 1906, honors Sir William Henry Perkin, whose discovery of the first synthetic dye spurred the growth of modern chemical industry. It is given by the American Section of the Society of Chemical Industry with the cooperation of other American chemical groups. Presentation of the medal was made by Wallace P Cohoe, New York chemical consultant and past president of the Society of Chemical Industry. Henry B du Pont, director and member of the executive committee of E I du Pont de Nemours & Company, Inc, told of the medallist's accomplishments and Harry B McClure, chairman of the American Section and vice president of Carbide & Carbon Chemicals Corporation, presided. Each guest at the dinner was given a dress tie made of modern synthetic fibers (Acrilan and rayon) and dyed mauve, the color of Perkin's first synthetic dye and recalling the silk ties worn at the 1906 meeting when the medal was founded.

• Annual Spring Weekend, PSC School of Home Economics

The School of Home Economics at the Pennsylvania State College will bring together specialists from industry, retail stores, consumer groups and from their own laboratories during their Annual Spring Weekend, April 17 and 18, to help answer various questions pertaining to clothing and other textiles. All users of textiles are invited.

Theme of this year's "Weekend" will be "Fashions, Fabrics and Families."

A detailed program may be obtained by writing to the School at State College, Pa.

Correction

Re: Advertisement, page XXXVI, Dec 8, 1952 issue.

On page XXXVI of the December 8, 1952 issue there appears an error relative to the date of a patent application by Teinturerie de Groeninghe.

Paragraph 10 states that the patent was applied for in the Netherlands in February, 1952. This should correctly read *February, 1949.*

• Dynel Dyeing Costs Cut By Improved Formulations

Reductions of as much as 59 percent in the cost of dyeing Dynel are claimed through new dye formulations in tests carried on at South Charleston, W Va, by the Textile Fibers Department of Carbide and Carbon Chemicals Company, a division of Union Carbide and Carbon Corporation, producers of the fiber.

T A Feild, Jr, head of Carbide's Development Service Laboratory, reports cost cuts on individual colors ranging from 30 to 59 percent. The new dye formulations are equal to the old in color fastness and depth of shades achieved, if not better, according to cotton wash and Fade-Ometer tests, Mr Feild stated. Improvements by reformulation were obtained primarily in acetate and acetate-acid color dyeings, and are the results of a program devoted to the more effective utilization of the newer dyestuffs and methods of application, he added.

The figures given cover costs of dyes and assistants only and do not include scouring or finishing agents.

The 59 percent cost decrease was reportedly achieved in dyeing all-Dynel sweater fabric in a green shade. While the cost of chemicals and dyes for the dyeing procedure formerly amounted to $16.09 per 100 lb of fabric, the new formulation, employing two new acetate dyes, is said to have brought this cost down to $6.56.

Other colors responded similarly to reformulation. A standard light blue, all-Dynel blanket fabric, formerly acid-dyed at an approximate cost for chemicals and dyes of $2.38 per 100 lb of fabric, was dyed with a mixture of acid and acetate dyes for $1.24. A fur brown shade formula on Dynel stock for a deep pile fabric was reformulated to include an acid blue instead of a more expensive acetate blue at a saving of 30 percent. New formulations used for maroon, navy blue and black shades in stock dyeing are said to have resulted in savings, respectively, of 56, 48, and 30 percent.

While "substantial savings" can be made by replacing certain expensive but customarily used dyes and chemicals with others, dyers must note that in some cases the less expensive dyes may require closer control in dissolving, Frank C Rippner pointed out. Mr Rippner, who supervised reformulation tests with a fur brown shade on Dynel at the Carbide laboratory, stressed that the less expensive Capracyl Blue G dye used in this formula must be properly dissolved and distributed evenly on the fiber, as the dye does not "migrate" as acetate colors do, and may not level on the fiber as well. Properly handled, however, the new formula gave "excellent" results, Mr Rippner reported. Light fastness was said to be "very good" at 20 hours and 40 hours, with only a slight break occurring at 60 hours.

Revision of the formulas for dyeing Dynel socks are in progress and substantial savings appear in sight, according to Mr Feild. Similar re-evaluations of the formulas used for Dynel stock will be made in the near future.

Mr Feild expressed confidence that lower cost procedures in dyeing will be developed in these areas.

A typical Dynel piece dyeing procedure as outlined by Mr Feild follows:

Shade: Green

Material: 100% Dynel Knit Fabric

Assistants: All percentages are based on the material

Dyeing:

"Tergitol" Wetting Agent 7	1.0%
Calgon	1.0%

Dyes:

Eastman Fast Yellow GLF	1.42%
Eastman Fast Blue GLF	0.53%

Approximate cost of all dyes and chemicals: for 100 lb of fabric—$7.09

Dyeing and Finishing Procedure—

Bath Ratio 30:1

1) Prepare dyebath at 100°F add "Tergitol" 7 and Calgon.
2) Add dispersed dyes, raise temperature to 212°F and run for 1½ hours. Cool slowly and rinse.
3) Scour at 160°F with "Tergitol" Dispersant NPX and Calgon. Rinse and dry.
4) Reluster under conditions established at the dyehouse.
5) For maximum wash fastness scour again at 160°F with 2% of soap, 1% of soda ash for 20 minutes—dry at temperatures below 210°F.

• Date of DCAT's 63rd Annual Meeting Set

The 63rd Annual Meeting and Election of the Drug, Chemical and Allied Trades Section of the New York Board of Trade (DCAT) will be held at Pocono Manor Inn, Pocono Manor, Pennsylvania, from September 24-27, 1953, according to Chairman Lloyd I Volckening (The Ivers Lee Company). The Executive Committee decided to return to Pocono Manor Inn in 1953, "since the first meeting held there this year proved so successful".

• ASA Asked to Initiate New Project

A conference of thirty-nine national organizations meeting in New York on January 9th has asked the American Standards Association to initiate a project for the development of standards for the performance of textile fabrics. The project will include articles purchased and used by hotels, hospitals, and other institutions.

The American Hotel Association, which originally proposed the project, explained that standards are needed to define the performance characteristics of fabrics that go into such items as towels, hotel uniforms, upholstery and drapery materials, table linens, overalls, and work shirts. Test methods are needed to check whether the fabrics meet the standard requirements.

The work will be similar to that done on the American Standards for Rayon, Acetate, and Mixed Fabrics, which define such requirements as tensile strength, colorfastness, washability, and similar characteristics needed for different specific uses.

It is estimated that hotels buy nearly 14 million towels, six million sheets, and five million pillow cases every year. On an average day, they send to the laundry more than 4 million towels and 2 million sheets. At present institutional buyers find it difficult to know what service they can expect from the fabrics they buy.

The American Hotel Association uses a research laboratory which tests products and equipment purchased by its 6,000 member hotels. Its work consists of checking samples of materials before purchase to determine their serviceability for specific uses and checking materials and equipment after purchase to determine the reasons for any failures. For this work standard specifications, test methods, and performance requirements are needed, it was explained.

Representatives of the cleaning, dyeing, and laundering industries participated in the discussions and expressed full support of the project. They indicated particularly the need for greater knowledge of the end uses to which fabrics are to be put and the necessity of more complete instructions as to conditions under which the articles should be washed or dry cleaned.

In expressing their approval of the project, representatives of the American Hospital Association called attention to the fact that American Standards for sheets and pillow cases have been useful to institutional buyers. A survey conducted recently shows that they are now in wide use. Standards developed under the procedures of the American Standards Association represent national agreement rather than the viewpoint of a single organization.

Representatives of consumer groups spoke in favor of the proposed project. They hoped that while the standards are developed for institutional purposes they can be adapted to fabrics for home use. They were assured that development of standards for institutional use would make it easier to develop standards for fabrics for the relatively milder wear given in homes.

The conference recommended that the American Hotel Association undertake the administrative responsibility for the project.

It was also recommended that standards be developed for the finished articles wherever possible.

It was explained that use of the standards developed, as in the case of all American Standards, would be entirely voluntary. These standards would be given wide publicity and distribution, but their actual use in the fabrics and end projects would come about by their voluntary acceptance by the manufacturers and their use by reference in the orders of commercial purchasers and ultimate consumers. The Hotel Association indicated that it would recommend use of the textile standards to its 6,000 member hotels, as it will do also in the case of the American Standards for Rayon, Acetate and Mixed Fabrics, now in press.

• Du Pont to Aid Chemistry's Role in 32 Colleges

A new program intended primarily to assist and advance the teaching of chemistry in American colleges and universities will be initiated by the Du Pont Company next fall.

Thirty-two institutions will receive new fellowships or grants for the next academic year as the result of a comprehensive survey by the company that revealed the need for such assistance.

In one plan under this program, grants have been made to 19 four-year private colleges to help them maintain their outstanding performance in the training of students majoring in chemistry.

In the other, the company has awarded postgraduate fellowships to 13 universities to improve the teaching of chemistry to undergraduates.

These new plans broaden the company's present program of support for postgraduate study and fundamental research in the universities.

An authorization of about $600,000 was provided by Du Pont for the new assistance and to continue its previous programs for fellowships and grants-in-aid for the academic year of 1953-54.

• New APC Sales Representatives

Sidney J Baum, Vice President and General Manager of American Polymer Corporation, Peabody, Massachusetts, has announced the appointment of Cole & DeGraf of San Francisco as sales representative.

• Quality Control Curriculum Added at N C State

The School of Textiles, North Carolina State College, has established a fourth-year optional curriculum in Textile Quality Control, under the direction of D S Hamby, associate professor at the school.

The purpose of the courses, Professor Hamby said, is to turn out graduates better trained to fill the growing needs of the textile industry for men trained in control and improvement of the quality of textile-mill products. In the past few years, he pointed out, 27 mills have hired graduates of the State College School of Textiles specifically for work in control of process and product quality.

The courses, he explained, will give graduates a thorough grounding in testing techniques, quality control methods, evaluation and interpretation of test results, and coordination of quality control with mill operations.

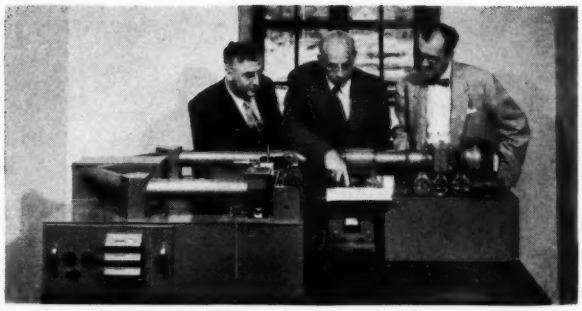
The subject matter of the courses to be included in the fourth-year option will be testing techniques, statistical analysis and evaluation, quality-control-chart techniques and programs, defect-preventive methods, military specifications, administration of testing and research programs, laboratory layout and organization, and process control.

• ICS Textile Director to Teach New Course at CCNY

John K Stearns, Director of the School of Textiles of the International Correspondence School, Scranton, Pa, will instruct in the Textile Unit of the City College of New York Midtown Business Center beginning February 16, it is learned.

Mr Stearns, who will commute from his headquarters in Scranton, will teach a Saturday class in Technology of Weaving. The inauguration of the course to be taught by Mr Stearns is part of an expansion of the Center's Textile Unit planned to provide a complete training program in New York for members of the textile industry.

Registration is now open for Mr Stearns' course and for eleven other textile courses which are part of the Midtown Business Center's 181-course spring program.



James F Thompson, (center), vice-president and general manager of The Hilton-Davis Chemical Co, Cincinnati, Ohio, explains the operation of a recording spectrophotometer to Henry Lievendag (left), of Sociedade Comercial Importadora "Radion" Ltda, which represents the chemical firm in Sao Paolo, Brazil. Nelson S Knaggs, Hilton-Davis' vice-president in charge of sales, is viewing the demonstration which was part of plant tour to acquaint Mr Lievendag with latest developments in colors for printing ink, textile and paint industries.

• Ansul to Produce Synthetic Pyridine Derivatives

Ansul Chemical Company of Marinette, Wisconsin, has announced that, effective in the spring, it will begin production of a half-million pounds annually of gamma picoline, alpha picoline, 2-methyl-5-ethyl pyridine and the higher alkyl pyridines. Production, which will be in a semiworks plant, is in the pilot plant stage now, with samples due to become available soon.

Last year saw a mushrooming demand for pyridine derivatives, which are by-products of coke. But since the yield of natural pyridine derivatives from coke is small (a fraction of one per cent) the supply is limited.

Increased demand has been caused by the rapid development of new water-proofing materials, solvents and new medicinals all using pyridine derivatives.

Ansul officials say competitive prices will be established later.

Gamma picoline has reached a world market price of approximately $4.00 a pound. Isonicotinic acid, made from gamma picoline, sells for about $8.00 a pound.

Ansul reportedly plans to sell most of its production, retaining a limited amount for processing into other compounds.

• 1953 Meeting Dates, ACCCE

Open meetings of the Association of Consulting Chemist and Chemical Engineers, Inc, for 1953 are scheduled as follows:

April 21, Hotel Belmont Plaza, New York, N Y—Symposium and dinner.

October 27, Hotel Belmont Plaza, New York, N Y—25th Anniversary—Annual Meeting—Celebration, entertainment and dinner.

• New German Scientific Journal

"Die Farbe", a new German scientific journal has begun publication of papers on the different problems of color science, such as color vision and its testing, color matching, light and color, evaluation of fastness, color photography, television and reproduction, color psychology and color conditioning, color standardization work and color nomenclature and terminology.

In addition to original papers, *Die Farbe* publishes reviews of other articles, book reviews, and news of events, persons and organizations concerned with color problems. Short abstracts in German and English at the beginning of each article inform the reader of the essential content.

Die Farbe is edited by Dr Ing habil Manfred Richter of Berlin.

For further information, write to Verlag fur Angewandte Wissenschaften GmbH, Wiesbaden, Rheinstrasse 79, Germany.

• AOCS Events for '53

Three events are on the 1953 calendar of the American Oil Chemists' Society: the 44th annual meeting in New Orleans at the Roosevelt Hotel, May 4-6; short course on processing of edible oils and edible oil seeds at Texas A & M College, College Station, Tex, the week of July 27; and the 27th fall meeting in Chicago at the Sherman Hotel, November 2-4.

Plans for the first two are already well advanced, with the following as their respective chairmen: J A Kime, Southern Regional Research Laboratory, New Orleans; and J D Lindsay, Texas A & M. The third will have as chairman A F Kapecki of Wurster and Sanger, Inc, Chicago.

• Program Set for 4th Cotton Research Clinic

Fifteen prominent textile scientists, including two from Great Britain, will speak at the fourth Annual Cotton Research Clinic, to be held Feb 18-20 at the General Oglethorpe Hotel, Savannah, Ga. Two of the sessions will be devoted to the initial processing of cotton while another will feature a discussion of fiber and yarn strengths. Two new instruments for measuring the strength and elongation of cotton fibers will be demonstrated.

M Earl Heard, West Point Manufacturing Co, heads an 8-man Advisory Committee for the Clinic, which is sponsored by the National Cotton Council. Serving with Mr Heard are J B Goldberg, director of research, J P Stevens Co; Milton Harris, president of Harris Research Laboratories, Washington; V B Holland, director of Research, Joanna Mills, Joanna, S C; Walter M Scott, assistant chief, Bureau of Agricultural and Industrial Chemistry, U S Dept of Agriculture; R Y Winters, assistant Administrator of Agriculture's Research Administration, USDA; George Buck, Technical Director of the Cotton Council; Hugh M Brown, dean of the School of Textiles, Clemson College, and Leonard Smith, director of the Cotton Council's Utilization Research Division.

• New Tall Oil Plant

Crossett Chemical Co, a division of Crossett Lumber Co, Crossett, Arkansas, has begun operations at a new plant for the production of high-grade whole tall oil, according to an announcement by E M Godat, Manager.

The new installation, which is reportedly set to produce at the rate of 6,000 tons a years, was designed by Arthur Pollak, New York consultant and outstanding authority on the technology and uses of tall oil and other pulp wood derivatives. Potential production capacity is said to be four times the present rate. Future plans call for the manufacture of refined, as well as whole tall oil.

Dr Pollak, who did the detailed drawings in addition to designing the plant, also specified the equipment. Rust Engineering Co was the builder. Ample storage capacity, close processing control and ideal transportation facilities are outstanding features of the new plant.

Other Crossett products are methanol, acetic acid and charcoal.

• TRI Sets '53 Annual Meeting Dates

P C Alford, Jr, Secretary of the Textile Research Institute, has announced that the 1953 Annual Meeting of that organization will be held on Thursday and Friday, November 12th and 13th.

• ASTM Committee on Soaps and Other Detergents to Meet

In addition to meetings of the various subcommittees concerned with specifications, test methods, and related problems, functioning in ASTM Committee D-12 on Soaps and Other Detergents, the annual meeting scheduled for the Park-Sheraton Hotel in New York, N Y, on March 16 and 17, will include a series of technical papers. Those interested in the subjects being covered are invited to attend. A list of the papers tentatively scheduled for presentation follows:

"Asphalt Tile Cleaning Agent Specifications", A C Zettlemoyer, Asphalt Tile Institute;

"Realistic Approach to Silicate and Phosphate Analyses in Synthetic Detergent Compositions", A M Mankowich;

"Action of Detergents in Sewage Treatment";

"Theory of Detergent Action", Irving Reich, Foster D Snell, Inc; and

"Analysis of Synthetic Detergents".

A subcommittee on "Sampling and Interpretation of Data" will hold its initial meeting.

• LTI Offers New Approach to Job Placement

A new approach towards greater efficiency in job placement has been accomplished at Lowell Textile Institute by means of the establishment of a Senior Career Room in the college's new Memorial Library.

Set up by Professor James W Bell, Director of Placement at the Institute, the room contains literature, pictures, financial reports, records, product samples, organization charts, histories, management lists, and a wealth of miscellaneous and permanent data concerning manufacturing plants in all parts of the United States.

Purpose of the Senior Career Room is to make available information about various textile, chemical, engineering and similar companies so that students, prior to being interviewed for positions, may study the background, scope and policies of the different organizations and tentatively decide upon the type of unit with which they wish to become associated after graduation.

NAMES IN THE NEWS

H E Hager

HERMAN E HAGER, long prominent in the affairs of the American Association of Textile Chemists and Colorists, has begun a three-month tour of the United States, with Mrs Hager, visiting the various offices of General Dyestuff Corporation.

Dr Hager, assistant technical director, technical department, RUDOLPH LENZ, vice president and manager of the prices and product line, and NORMAN PETERKIN, advertising manager, retired from General Dyestuff Corporation on December 31st. ROBERT J HAMILTON, who has been with GDC since 1930, succeeds Mr Peterkin. Both Dr Hager and Mr Peterkin will act as consultants for the company in the future.

Dr Hager's activities in AATCC will continue, it is learned. As Chairman of the Flammability Committee he has seen the development of the flammability tester for consumer fabrics, among other developments of national importance, and has served on Committees for Atmospheric Fading, Color, Washfastness and Lightfastness. A Past Chairman of the New York Section, he is currently serving it as Corporate Membership Committee Chairman. He has also served the Section as Head of the Ladies Committee at the 1951 Convention, was a member of previous Intersectional Contest and National Technical Program Committees, and during the "Victory Convention", was in charge of exhibits.

Dr Hager's 42 years with the dyeing and finishing industry began at M T Stevens & Co, Inc, Franklin, N H, where he worked with woolens. He later went with Pacific Mills in Lawrence, Mass, before joining Bayer Company in 1913, later aiding in the building of that firm's Albany plant, one of the earliest dyestuff producers in the U S. In 1924 he became head of the New York laboratories of Grasselli Dyestuff Corp, from whence emerged General Dyestuff Corporation in 1925.

HERBERT J BALL, Head of the Department of Engineering, Lowell Textile Institute, has been named to receive the Harold De Witt Smith Memorial Medal.

Committee D-13 on Textile & Materials, of the American Society for Testing Materials, will make the Award at its March 19 meeting in the Park-Sheraton Hotel, New York City.

The medal, a testimonial to the memory of the late Dr Harold De Witt Smith, was established in 1949 by Fabric Research Laboratories, Inc, Boston. It is awarded at intervals of not less than one year by Committee D-13. Professor Ball, who was Chairman of D-13 from 1930 to 1950, will be the fourth recipient of the medal.

The medal is awarded for outstanding achievement in the field of textile fiber science and utilization, which includes the development and promotion of knowledge of textile fibers and structure, and/or methods for the evaluation of their properties.

THE Rodney Hunt Machine Co. Orange, Mass, has announced the appointment of JACK W REMBE as Sales Manager. Mr Rembe has been export manager of the firm for the past five years and will now direct the sales activities of the company's five product divisions in both domestic and export markets.

Before becoming associated with Rodney Hunt, Mr Rembe held supervisory positions in the bleaching, dyeing, finishing and purchasing departments over a twelve-year period with the Cold Spring Bleachery, Yardley, Pa. He was also associated with De Laval Steam Turbine Company in production control.

J W Rembe

25-Year Merit Award to NPA Official

LYALL TRACY (far right), Assistant Deputy Administrator of the National Production Authority, receives certificate and watch from CLYDE B MORGAN, President of Rayonier Inc, chemical cellulose producer, during silver anniversary celebrations at the Hotel Biltmore on Dec 12. Onlookers are, from left to right: WILLIAM E BREITENBACH, company Vice President —also a 25-year award holder; President Morgan; JAMES T SHEEHY, Executive Vice President; CHARLES H CONRAD, another award recipient; and Mr Tracy. 40 Rayonier employees have been with the company during the first 25 years.

GEORGE W SCHWARZ, since 1948 vice president-controller of Wyandotte Chemicals Corporation, has been promoted to vice president and treasurer. In assuming supervision of the financial administration of Wyandotte Chemicals Corporation and its transportation and mining subsidiaries, Mr Schwarz relinquishes the controllership after a long career in accounting. He came to Wyandotte in 1938.

The functions of treasurer have been handled by FORD BALLANTYNE, SR, who will continue to serve as vice president and secretary of the company.

GEORGE H BAKER has been elected vice president in charge of the employee and public relations department, an elevation from that department's directorship. Mr Baker came to Wyandotte from the American Potash and Chemical Corporation in September, 1950, following broad experience in the field of human relations in both industry and government.

RECENT personnel news from Hooker Electrochemical Company includes the following:

F L BRYANT has been named superintendent for the Niagara Falls plant and J D SWEENEY has been named superintendent of production. Mr Bryant had been plant superintendent. In his new capacity he will be in charge of production, maintenance engineering, traffic and plant stores. He has been with Hooker since 1935. Mr Sweeney was most recently a trainee as area supervisor in charge of several operating departments. He joined Hooker in 1937 and, since 1951, has been in charge of the company's Chemical Corps plant.

ANSLEY WILCOX 2nd has been named general counsel of Hooker. Mr Wilcox has been secretary of the firm since 1941 and will continue in that capacity as well.

J A TARDIFF has been appointed works manager, J T RUTHERFORD has been named production superintendent, and G E DUCKWALL has been made plant engineer for the new caustic soda-chlorine plant now under construction at Montague, Michigan. The three men will assume their new responsibilities later in 1953 when construction of of the new plant is complete. In the meantime they will continue in training at Niagara for their new jobs.

H B YOUNG, works manager of the Niagara plant, will also be in charge of operations at Montague, Michigan and of the Hocker-Detrex plant at Ashtabula, Ohio, with headquarters at Niagara Falls.

J C Conniff

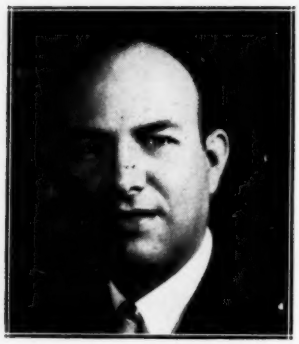
J J Newton

DAN RIVER MILLS has announced the promotion of JOHN C CONNIFF to director of employment and the appointments of JOHN J NEWTON as superintendent of the No. 3 Division at Schoolfield and EDWARD R HOPKINS as section superintendent of rayon dyeing and finishing operations at the Riverside Division.

Mr Conniff replaces ERNEST G WIGFIELD who resigned on January 1st to accept a position as director of personnel with the American Safety Razor Company. Mr Conniff has been with Dan River since January of 1946, when he joined the company's Industrial Engineering Department as head of Methods and Procedures. Previously he was Brand Manager of the Advertising Department of the Procter and Gamble Company of Cincinnati, Ohio, and Commodity Expert on Cotton Textiles for the U S Tariff Commission.

In his new post Mr Newton will be in charge of all dyeing and finishing operations at the Schoolfield plant. He recently joined the Dan River organization from A D Juilliard and Company, Incorporated, of Utica, N Y. Before joining Juilliard he was associated with the Martin Dyeing and Finishing Company of Bridgeton, N J, and the Fairforest Finishing Company in Spartanburg, S C. He replaces J J CARRICK who recently resigned.

Mr Hopkins was formerly Technical Superintendent of Finishing at the pilot mill in the company's Research and Development Division. He joined Dan River in February, 1951. Previously, he had been Manager of the Patchogue Dyeing and Finishing Company of Patchogue, N Y. He had also been associated with Stonecutter Mills of Spindale, N C and the United Piece Dye Works, Incorporated of Lodi, N J.



E A Robinson

THE election of EDWIN A ROBINSON as a vice-president of Nopco Chemical Company, effective January 1, has been announced by Thomas A Printon, President, from the company's home offices at Harrison, New Jersey.

Dr Robinson came with Nopco from the Tennessee Eastman Corporation in 1936, and became an assistant vice-president in 1951. As vice-president he will be in charge of the Nopco Textile Fibers Department and the Textile Specialties Department, which handle the development and sale of fiber lubricants and other chemical specialties for the textile yarn manufacuring and processing industries.

Other promotions include that of C I POST to vice-president in charge of Vitamin Division sales and research; and the naming of three new assistant vice-presidents: HARRY A BATLEY, in charge of Industrial Division manufacturing, pilot plant and semiworks operations, and plant coordinating; GEORGE G STIER, to head the company's new Lockfoam Division, Industrial Market Development, and be responsible for military orders and contracts; and WALTER B MOREHOUSE, sales manager for the Paper Chemicals Department and supervisor of all Industrial Division field personnel including district sales managers and technical sales representatives.

THE appointment of CARL DEGLIALBERTI, Acting Director, Research and Development Division, U S Navy Clothing Supply Office, as Supervisor of the Textile Unit, City College of New York Midtown Business Center, has been announced.

Mr Deglialberti's duties will include supervision of the textile unit's expanded curriculum as well as instruction of the unit's Basic Textiles and Textile Testing and Fabric Analysis courses. In recent months Mr Deglialberti has been active in the development of winter clothing and shrinkproof fabrics for the armed forces.

G C Stefango

F F Sampson, Jr

SEVERAL organization changes in the Purchasing Department of Owens-Corning Fiberglas Corporation, designed to decentralize purchasing functions and to improve service to the firm's major operating divisions, have been announced by Ben S Wright, Vice President for Purchases and Trade Relations.

GEORGE C STEFANGO has been named manager of purchases of the General Products Division with headquarters in the Fiberglas General Offices in Toledo. Mr Stefango is responsible, with the plant purchasing agents, for procurement for Owens-Corning's General Products Division plants in Newark, O, and Kansas City, Kan.

FRED F SAMPSON, JR has been named manager of purchases of the Textile Products Division, headquartered in the Fiberglas Building at 16 East 56th Street, New York, N Y. Mr Sampson is responsible, with the plant purchasing agents, for procurement for Owens-Corning's Textile Products Division plants at Anderson, S C, Ashton, R I, and Huntingdon, Pa.

J T ENGLEHARDT has been named supervisor of purchases of the Research, Development and Engineering Division in Newark, O.

W C McMURRAY continues as purchasing agent of the Pacific Coast Division with headquarters at Santa Clara, Cal.

HAROLD W TAFT, formerly director of purchases, has resigned, and the duties of that position are being reassigned under the new organization.

JOHN W STEVENS and ROBERT W KAMPSCHULTE have been named General Sales Manager and Assistant General Sales Manager, respectively, of the Chemical Division of Celanese Corporation of America. Both have had similar responsibilities in the past, but the new titles have been established in keeping with the increased scope and diversity of the division's activities.

Other appointments have been announced as follows: WILLIAM C GOODWINE as Sales Manager in Charge of Plasticizers; A R COCKRAN, Manager of Plant Operations, Chemical Division; and WILLIAM P ORR, Assistant to Manager of Plant Operations, Chemical Division. K D BOWEN, who had previously been Manager of Plant Operations for the Chemical Division, has been appointed to the new position of Director of Manufacturing Co-ordination for the entire company.

At Celanese's Summit (N J) Research Laboratories, B SHELDON SPRAGUE has been named Section Head in charge of textile evaluation research and HAROLD K HUGHES as Section Head in charge of dry spinning research. Mr Sprague joined the Plastics Division in Newark in 1947 and was transferred to Summit when the laboratories were opened. Dr Hughes joined Celanese in January, 1952. Previously he was assistant supervisor of the special analytical section of the Socony Vacuum Laboratories in New York.

P H GROGGINS has been engaged as General Chemical Consultant by the Administrative Office for the Chemical Divisions of Food Machinery and Chemical Corporation. In this office, which is headed by ERNEST HART, an Executive Vice President of the Corporation, Mr Groggins will report to M Y SEATON, Senior Vice President and Technical Coordinator of the Chemical Divisions.

Mr Groggins retired on January 1st from a twenty-six year term of service in the employ of the U S Government where he had long been connected with the Department of Agriculture, and more recently, with NPA. Prior to his Government connection, he had seen service with a number of private chemical concerns, including Monsanto and Du Pont.

MARTIN H GURLEY, JR has been appointed Manager of the Technical Department of the Duplan Corporation at Kingston, Pa. Previously, he was an independent consultant with Laboratories at Pawtucket, R I.

AMBROSE R CHANTLER, one of the deans of American dyestuff industry, has retired after 34 years with the Du Pont Company.

Mr Chantler, one of the first of the young men who grew up with the industry at its start in World War I, was particularly active throughout his career in the development of vat colors and expanding their use in the printing and finishing industries. In World War II, he served on the Dyestuff Industry Advisory Committee to the War Production Board and devoted much of his personal time to the application of fast colors for all types of military equipment. During this past year, he served as president of the Synthetic Organic Chemicals Manufacturers Association.

Born in Pawtucket, Rhode Island, Mr Chantler received a bachelor of science degree in chemical engineering from Rhode Island State College in 1916. After service in the Army in World War I, he joined the United States Finishing Company in Providence, Rhode Island, as a textile chemist.

In 1919 he came with Du Pont as a dye salesman and after five years was appointed assistant director of sales of the Dyestuffs Division. He was named director of sales in 1929 and served in that capacity for over 20 years until he was made sales adviser for the Organic Chemicals Department in June of 1950.

Mr Chantler is a member of the American Association of Textile Colorists, the Wilmington Country Club, the Du Pont Country Club, and the Merchants Club of New York City. The Chantlers reside at 1105 Brandon Lane, Westover Hills, Wilmington, Delaware.

FRITZ DEGENER has been appointed General Sales Manager of Chemicals for Heyden Chemical Corporation, effective January 12th.

Mr Degener, who has been associated with Heyden since 1930, has been assistant sales manager since 1948. He served as Sales Manager of Heyden's Chicago Branch Office from 1938 to 1948.

Before joining Heyden, Mr Degener was a sales representative for Winthrop Chemical Company in the Chicago District.

ELLWOOD EDDINGTON has been named Assistant Plant Manager of Duplan Dyeing Company, Ltd, Valleyfield, Quebec.

Mr Eddington has been with Duplan for a year and a half as plant superintendent. Previously he was with Cluett Peabody & Co and Calco Chemical Division, American Cyanamid Co.

J F Shea

F N C Jerauld

JOHN F SHEA, formerly northeastern district sales manager of Buffalo Electro-Chemical Co, Inc and a member of the sales force since 1930, has been appointed General Sales Manager. Mr Shea will make his headquarters in Buffalo, N Y.

The appointment of FRED N C JERAULD, formerly assistant to the president, as Manager of Sales Promotion, has also been announced. Mr Jerauld has been with the company since 1936.

ROBERT W CAIRNS, assistant director of research for Hercules Powder Company, has been named vice-chairman of the Research and Development Board, a staff agency of the Secretary of Defense.

The appointment was announced in Washington on January 12th by Walter G Whitman, chairman of the board which guides the weapons development program of the Army, Navy and Air Force.

Dr Cairns will be on loan to the government for one year, serving without compensation. He has been assistant director of the Hercules Research Department since 1945.

In his new post, Dr Cairns will devote his full time to problems of national defense. To some degree, he has been involved with the same problems on a part-time basis since the beginning of World War II.

R F McKown

HART Products Corporation, has announced the appointments of ROBERT F McKOWN as manager of their Spartanburg, South Carolina, branch office.

Mr McKown resigned as General Superintendent of the Finishing Plant, Ware Shoals Division, Riegel Textile Corp, effective January 1. He first joined Ware Shoals in 1940 as Assistant Dyer resigning in 1945 as overseer of the dyehouse to become General Superintendent of Kerr Bleachery and Finishing Works. He remained with Kerr for two years and resigned to return to Ware Shoals in 1947 as Night Superintendent of Rayon. He quickly advanced to Assistant Superintendent of Cotton Finishing and in 1949 was promoted to General Superintendent.

Mr McKown will spend most of his time in the field.

RAYMOND F SCHULTZ, Technical Director of the Experiment Station of Hercules Powder Company since Nov, 1951, has been named Special Assistant to the Director of Research. He has moved to the company's central offices in Wilmington.

PETER VanWYCK, formerly Associate Technical Director of the Experiment Station, has become Station Director.

HOWARD G TENNENT, Manager, Experiment Station, will continue in that post, reporting to Dr VanWyck.

VOLNEY R CROSSWELL, a pioneer in the naval stores field and a veteran of nearly 41 years's service with Hercules, retired on December 31st having served in managerial capacities at five Hercules plants.

AMERICAN POLYMER CORPORATION, Peabody, Mass, has announced the apointment of L J BAXTER as Director of Customer Service Department, a special department designed to expedite delivery of orders, to coordinate and trace shipments, and to facilitate requests for special products in pilot plant or experimental production.

J C Clay

PROMOTION of JOHN C CLAY as Deputy Assistant Administrator of NPA was announced recently by Lyall Tracy, Assistant Administrator for the Chemical, Rubber and Forest Products Bureau, National Production Authority, Department of Commerce. Mr Clay was formerly Director, Containers and Packaging Division.

In his new duties, Mr Clay will will have the responsibility for mobilization planning, all priorities, certificates of amortization and other activities of the following Divisions: Containers and Packaging, Chemical, Pulp and Paper, Lumber and Wood Products, Printing and Publishing, and Rubber.

Mr Clay is on leave as assistant to the executive vice president of National Starch Products Inc, New York, where he has been associated for over 16 years.

THE appointment of MILDRED BARNWELL ANDREWS as Public Relations Director for the American Textile Machinery Exhibition of 1954, an event sponsored by the American Textile Machinery Association, has been announced by J Hugh Bolton, President of the Association, and WILLIAM K CHILD, Chairman of the Association Exhibition Committee.

For more than sixteen years Mrs Andrews was executive secretary of the Southern Combed Yarn Spinners Association. From 1946 until recently she was active in the organization of the textile mills' industry-wide public relations activity, serving as committee representative of the textile committee of public relations.

During World War II she served as special consultant for textiles in the Research and Development Section, Military Planning Division, Office of the Quartermaster-General, as a member of the War Production Board, Division of Industrial Salvage. During that period she won the American Trade Association Executive Award for War Production Achievement.

Mrs Andrews resides in Vienna, Va, where her office headquarters will be.

RECENT developments within American Cyanamid Company include the following: GURDON WATTLES has been elected a director of the Company.

Specialty Products Department—HUGH PUCKETT, formerly Southern District Manager of Industrial Chemicals Division, has been named manager of the Specialty Products Department. He has been associated with the chemical industry since 1922, the past 25 years of which were with Cyanamid's Industrial Chemicals Section. A native of Charlote, N C, where he will continue to make his headquarters, Mr Puckett began his career in the Charlotte offices and laboratories of National Aniline and General Dyestuff Corporation. He joined the sales force of Charles H Stone, Inc, Charlotte dyestuff and chemical jobbers, in 1928 and was vice-president of that organization when it merged with American Cyanamid and Chemical Corporation in January, 1937.

H Puckett

Textile Resin Department — ROBERT L GREASON has been named assistant to the Advertising and Sales Promotion Manager. Mr Greason, who was formerly with the Fashion Merchandising Department of *Good Housekeeping*, will work on an intensified publicity and promotional campaign on Cyanamid's functional finishes for textiles.

R L Greason

North American Cyanamid Ltd—WILLIAM R GEDDES has been elected vice-president, WALTER G McBURNEY has been appointed Technical Director and THOMAS P TURCHAN has been named Plant Manager of the Niagara Falls, Ontario plant.

Mr Geddes joined NACL in 1948 and was assistant to the president until his recent advancement. He is also president of Chemical Construction (Inter-American) Limited. Both are Canadian associates of American Cyanamid Company.

Mr McBurney, who served as Plant Manager at Niagara Falls prior to his recent appointment, will be engaged in a program of long-range technical planning. He will be available for consulation on electrical problems on a Cyanamid-wide basis in the United States, Canada and South Africa.

Mr Turchan was manager of the Niagara Falls, New York Division of Stauffer Chemical Company before coming to Cyanamid in September, 1952.

LAWRENCE W BASS, industrial research executive, has become associated with Arthur D Little, Inc, consulting research and engineering firm, according to an announcement by Earl P Stevenson, president of the Cambridge, Mass, organization.

Dr Bass brings to this work over twenty years' background in research management. He had most recently been vice-president in charge of research for U S Industrial Chemicals Company, where he had responsibility for all research and development work on chemicals, insecticides and synthetic resins. Previous to that, he had been director of research for the Borden Company from 1931 to 1936, and assistant director of Mellon Institute from 1937 to 1942. As director of the New England Industrial Research Foundation during the following two years, Dr Bass acted in an advisory capacity for numerous companies and trade groups on development of new business, and from 1944 to 1948 served as director of chemical research for Air Reduction Company.

JOSEPH BECKER, one of the nation's foremost authorities on chemical-recovery coke oven design, construction and operation, has eased up on his duties after nearly 50 years of service to industry.

His retirement on December 31 as Vice President and General Manager, Engineering and Construction Division of Koppers Company, Inc, has been announced by General Brehon Somervell, Chairman and President of Koppers. Mr Becker will remain, however, as a consultant to Koppers.

With Mr Becker's retirement, GEORGE M CARVLIN, Vice President and Assistant General Manager of the Koppers Division, has been elevated to the post of General Manager.

APPOINTMENT of CARLTON BATES as Executive Vice President of Solvay Process Division, Allied Chemical & Dye Corporation, was recently announced.

Mr Bates was appointed a Vice President of Solvay in July 1951. As has been the case for the past ten months, he will continue to make his headquarters at Solvay's executive offices in New York.

FRED J STOCK, Assistant to the Director, Drug and Pharmaceutical Division, Mathieson Chemical Corp has been reelected Vice-President of the New York Board of Trade. He is one of three Vice-Presidents.

ROBERT B MAGNUS, Vice-President of Magnus, Mabee & Reynard, Inc, was reelected Treasurer.

The elections took place at a meeting of Directors held recently at the India House.

The following representatives from the drug and chemical industry were elected to the Directorate: STANLEY I CLARK, Sterling Drug Inc, CHARLES E DUTCHESS, Schenley Laboratories, Inc, CLAUDE A HANFORD, Pharmaco, Inc, CHARLES P WALKER, JR, Chas Pfizer & Co, Inc, and Mr Stock.

SIXTEEN women who work in the fabric field are featured in the January issue of *Glamour*. Along with photographs of each, the monthly Job Department article capsules the careers of ELSIE MURPHY, president of S Stroock & Co, Inc; DAISY WEICHEL, saleswoman for R C Harvey Co; MARCELLE FEYBUSCH, Fuller Fabrics' advertising, promotion and publicity director; WINIFRED PARDEY, manager of the fastness-testing department at General Dyestuff Corp; HOPE SKILLMAN, head of Skillmill; and ANN BOUCHER, Lord & Taylor fabric buyer.

In a companion feature, fashions are modelled by PEG BENDER, Celanese advertising; HELEN BOYD, Fashion Publicity Director for Deering Milliken & Co; CHRISTINE ECKER, Fashion Coordinator for Dan River Mills; JEANNE PIERRE, Fashion Director for A D Juilliard & Co; PAULINE ALPER, Fashion Coordinator for Burlington Mills; KATHRYN RICKMAN, Fashion Coordinator for J P Stevens & Co; LYNN GIVEN, Fashion Coordinator for Dobeckmun Company; LOUISE BRALOW, Retail Advertising and Promotion Director for Miron Mills, and MURROW McCURNIN, Fashion Director for Crompton Richmond.

According to *Glamour*, the fifteen "all prove by example the importance of women's place in fabric industry today."

B L Sen

B L SEN has joined the Dyes Department of Bunge & Co Ltd (Bombay, India), as a technical officer, where he is undergoing special technical training in the laboratory. Bunge & Co Ltd are now exclusive representatives in India for the Indigosol dyes of the Swiss firm Durand & Huguenin, AG (Basle).

Bunge & Co Ltd's world-wide organization has its headquarters in Buenos Aires with branch offices in New York and other American cities. Their London office supervises all Eastern branches.

HUGH C OSBORN has been appointed Technical Representative of the Portland, Oregon office of General Dyestuff Corporation.

Before joining GDC, Mr Osborn was a paper chemist and later a sales and service engineer for the R T Vanderbilt Company, Norwalk, Conn.

ROY T COWING has been appointed branch sales manager for the Merrimac Division of Monsanto Chemical Company at its Charlotte, N C office. ROBERT N FOSTER was named technical sales specialist in textile chemicals for that area. Both assignments are effective immediately.

Mr Cowing will be succeeded as consumer products manager of the Merrimac Division by WINFIELD E DROWN, alcohol and solvents sales manager.

Mr Cowing joined Monsanto in 1935, serving in various sales posts in New York, Philadelphia and Boston.

Mr Foster was employed by Monsanto in 1926. He has served on the Merrimac sales force since 1945.

ALPHA CHAPTER, Phi Psi Fraternity, located at the Philadelphia Textile Institute, inducted FRANK P ZURN, Chairman of the PTI Board of Governors, and JOHN H THOMAS, vice president, Textile Division, Owens-Corning Fiberglas Corporation, as honorary members at their annual Founder's Day Banquet, January 14th at the Anchorage Restaurant, Philadelphia.

ROBERT J HAMILTON, JR has been named advertising manager of General Dyestuff Corporation to succeed NORMAN PETERKIN, who retired on January 1st. Mr. Hamilton will handle all advertising for both the Dyestuffs and Antara Divisions of GDC. He has been associated with General Dyestuff since 1929 as an assistant to H W MARTIN, Secretary, and later to R LENZ, vice president, whose retirement was also effective January 1st.

S H WILLIAMS, GDC vice president and general sales manager has announced the resignation of RAYMOND B TAYLORSON, who has served as assistant manager of the Providence, R I branch for the past two years.

JAMES BALLOCH has joined the sales staff of Jacques Wolf & Co, and will cover South Carolina, Georgia and Tennessee.

Mr Balloch was formerly with Pacific Mills, Lyman, S C, and Renfrew Bleachery, Travelers Rest, S C.

APPOINTMENTS for 1953 by Association of Consulting Chemists and Chemical Engineers, Inc include the following: ROBERT T BALDWIN, Exec Secretary and Asst Treasurer; A B BOWERS, Director of Publicity and Asst Exec Sec'y.

THE appointment of HUGH W GRAY as laboratory director of the Textile Fibers Department's Pioneering Research Division has been announced by the Du Pont Company. ALLAN K SCHNEIDER was promoted to succeed him as a research supervisor in the Chemical Department at the Experimental Station in Wilmington.

Dr Gray, who is 40 years old, came with Du Pont in 1939 as a chemist with the Chemical Department at the Station. He was made a research supervisor there in 1946, continuing in that capacity up to the time of his present appointment.

The Pioneering Research Division is primarily concerned with the origination and development of new textile fibers. In his new position, Dr Gray will direct the work of the Pioneering Research Laboratory. The work embraces the fields of organic chemistry, physical chemistry, physics, and engineering and process development.

Dr Schneider, 36, joined Du Pont in 1941 as a chemist with the Chemical Department at the Station and became a senior research worker there in 1951, from which position he was promoted to research supervisor.

OBITUARY

JACK EPELBERG

FOLLOWING a month's illness, Jack Epelberg, Head of Chemical Process Research in the Research & Development Division, Cluett, Peabody & Co, Inc, died on December 26, 1952.

Dr Epelberg was very active in the affairs of the Hudson-Mohawk Section, American Association of Textile Chemists and Colorists, having served as its first Chairman. In addition he has filled several sectional committee chairmanships, and, at the time of his death, was a national councilor.

Born October 7, 1913, Dr Epelberg attended schools in Warren, Pa, and in 1936 received his B S in Organic Chemistry from the University of Pittsburgh. From 1936 to 1940, while pursuing his Ph D at the University of Pittsburgh, he was engaged as a laboratory instructor of organic chemistry. He was a member of Sigma Xi, Phi Lamda Upsilon and Pi Tay Phi. He was also a member of the American Chemical Society.

Dr Epelberg entered the employ of Cluett, Peabody & Co, Inc. on December 15, 1942, as a research chemist.

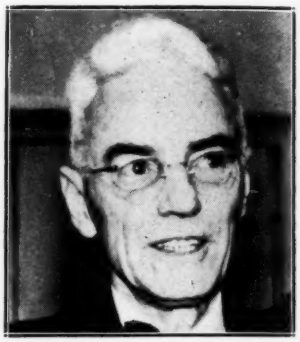
Surviving are his widow, the former Pearl Toppal of Troy, N Y, a son, Bruce, and a daughter, Sandra.

THOMAS J STARKIE

THOMAS J STARKIE, vice president, director and member of the executive committee of Witco Chemical Company, and director of Witco Chemical Company, Ltd, died December 21.

Born in New York, N Y on December 2, 1892, Mr Starkie began his career in the chemical field with Harshaw Chemical Company. He joined Witco in June, 1921.

Mr Starkie's club memberships included the Uptown Club, the Chemist's Club, the Salesman's Association of American Chemical Society and the New York and National Paint Clubs.



Thomas J Starkie

Mr Starkie is survived by his widow, Nellie Wright Starkie; a son, James M; and a daughter, Elizabeth E Starkie.

• PATENT DIGEST •

PAUL WENGRAF

DYEING WOOL WITH METALLIZED AZO DYES—— Treatment with Aldehydes Having Affinity for Wool

C, 4, 06

U S Pat 2,602,722
(Ciba Ltd——Widmer, Buehler, Roesti——
July 8, 1952)

As is generally well known, complex chromium azo dyes of the "Neolane" and "Palatine Fast" types require lengthy dyeing periods. Most of them (with some exceptions noted in this specification) have the disadvantage of decomposing during the dyeing process, probably by partial demetalization of the complex compound, and dull dyeings result. This has been largely overcome by a process described in USP 2,422,586 (American Cyanamid Company), in which a lower aldehyde (formaldehyde) is added to the dyebath, but maintenance of the proper aldehyde concentration in the bath throughout the process is difficult, volatilized aldehydes must be supplied, and unreliable dyeings will result unless additions are exact.

In place of volatile aldehydes, the use of water-soluble compounds of aldehyde character, having ionizable (sulfuric or carboxylic) groups that are adsorbed by wool to the extent of at least 60%, will solve the problem of maintaining aldehyde in the necessary amounts during the dyeing operation, according to USP 2,602,722. These aldehyde derivatives may or may not be colored. If they should be colored, it is preferable that they act as greenish-yellow dyestuffs, changing the original shades of blue- to green-colored chromium complex azo dyes only slightly. Numerous examples of the colorless types (having affinity for wool) are offered. They may contain acid radicles, such as phosgene, cyanuric chloride or imino groups in various compounds, having the characteristic of bearing aldehyde groups (CHO) as well as a sulfonic group in common. One of these aldehyde derivatives contains one benzaldehyde and one benzene sulfonic acid group linked to a triazine ring by an imino group. A more complicated product, a dialdehyde compound, contains two benzaldehyde and two triazine groups attached to the diamine diphenyl disulfonic acid. The dyeing procedure follows the customary Neolane-dye method, i e, heating the bath (containing a green chromium-complex azo dyestuff, sodium sulfate, sulfuric acid and one of the aforementioned products) for one half hour to the boil, adding some more sulfuric acid and dyeing for another 1½ hours. A pure level green shade is obtained in contrast to a duller and bluish dyeing when the aldehyde derivative is omitted.

Among other references cited by the Patent Office:

U S Pat 2,516,496 (Ciba/1950) (cf *Am Dyestuff Reptr 40*, 67, 1951): dyeing wool with chromium-complex azo dyes in acid baths and aftertreating with hot aldehyde (formaldehyde) solution rather than adding the aldehyde to the dyebath.

U S Pat 2,472,910 (Du Pont/1949): derivatives of tetrahydro-hydroxy-naphthamido-benzaldehydes as color-forming materials. Dyestuffs prepared from these compounds retain their reactive aldehyde function and produce washfast dyeings.

U S Pat 2,422,586 (American Cyanamid/1947): dyeing wool with metallized azo dyes, containing an amido group and one hydroxy group in o-position to the azo groups, in the presence of formaldehyde and formaldehyde-yielding agents. (cf *Am Dyestuff Reptr 36*, 665, 1947). . .

U S Pat 1,978,800 (Levy/1934): a furskin dressing process consisting of a treatment with urea-formaldehyde, a treatment with cuprammonium sulfate or a similar complex metal-ammonium compound for mordanting, subjection of the material to bleaching and optionally dyeing.

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